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PLANIGRAPHY IN THE DIAGNOSIS OF BRONCHOGENIC CARCINOMA*

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BRONCHOGENIC carcinoma appears to be increasing in frequency both absolutely and in proportion to other types of malignancy. Westermark,[11] in an analysis of his material from Sweden in 1939, reported that cancer of the stomach occurs 6.5 times as frequently as cancer of the bronchus while in Nystrom's statistics from Sweden in 1911-1912 cancer of the stomach occurred 74.5 times as often as cancer of the lung. In certain clinics in this country cancer of the lung is second only to cancer of the stomach in frequency as a cause of death in older individuals. There is no good explanation for this marked increase in incidence. The increase in life expectancy may have increased the number of cases of bronchogenic carcinoma more than other types of malignancy.

Certain methods of diagnosis have occupied the first place in the recognition of carcinoma of the lung in the living individual. Bronchoscopic examination has been of great value and has the added advantage of providing a means of biopsy. Many surgeons are not well trained in the technique of bronchoscopy and the method has been steadily improved upon. There is no comparable method by which the absolutely certain diagnosis so desirable to permit exploration of the thorax can be achieved. There are still many cases, however, in which bronchoscopy is accomplished with difficulty. It requires the use of anesthesia, either local or general, which is time-consuming. Good patient cooperation is required and to many individuals it is a frightening procedure. The poor condition of some patients prevents its use entirely.

The bronchi are not always easily examined by endoscopic methods. Particularly is this true of the upper lobe bronchi which are often technically difficult to visualize with the bronchoscope because of their sharp angulation. Certain anatomical variations of the bronchi or marked distortion of the bronchi from extrinsic lesions often prevent a satisfactory examination. While it is agreed that a positive biopsy is extremely important in the presence of a suspected tumor, a negative biopsy by no means excludes a tumor. Therefore, not infrequently, bronchoscopy is disappointing.

Great advances have been made in the

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roentgenological diagnosis of bronchial lesions. The secondary manifestations of bronchial obstruction are well known and in many cases the trained observer can make a diagnosis of the presence and anatomical position of a bronchial mass from the ordinary routine roentgenograms in various positions. When the presence of a bronchial tumor is suspected, either from the history or from the usual chest roentgenogram, fluoroscopic examination should be carried out. This will be useful in determining the position of the lesion, the location of atelectasis if present, and any alteration in the physiology of respiration. Furthermore, the fluoroscopic study affords the best means of determining the positions in which roentgenograms should be made. Films made in both phases of respiration, especially at the extremes of expiration and inspiration, often demonstrate to the best advantage the presence of emphysema or atelectasis. Obstructive emphysema is best demonstrated in the expiratory phase and a shift of the mediastinum toward the opposite side may be present.

The more common manifestations of bronchogenic carcinoma are well known. A mass either in the hilum or less commonly in the periphery, a localized abscess, an infiltrative process either localized or throughout one lung may be present. More important still are the evidences of bronchial obstruction; that is, localized or unilateral emphysema, atelectasis, bronchiectasis, chronic lung inflammation. Westermark[10,11] has described three stages in the development of bronchial tumors. In the first stage, there is diminished air content in the segment of the lung involved because of diminished intra-alveolar pressure and hyperemia. The second stage results from an increase in size of the bronchial mass producing a check-valve effect and resulting emphysema. The third stage is that of complete obstruction and atelectasis.

In spite of these well known findings resulting from bronchial tumors, the lesion may be present in an atypical form and may defy recognition. Any method which could actually demonstrate the tumor itself in a high percentage of cases would be extremely useful.

The instillation of iodized oil into the bronchi is a feasible and highly accurate procedure. With the exception of bronchoscopy, it is, no doubt, the most useful method for the delineation of an intrabronchial tumor. There are certain contraindications to bronchography, however; in some cases these are sufficient to exclude the method entirely. Furthermore the procedure is not without complications and difficulties so that it is not universally applicable.

One hesitates to administer iodized oil where dyspnea is present. Fever and toxicity are important contraindications. Reactions from local anesthesia, a necessary preliminary for bronchography, are rather infrequent, but are distressing when they occur. Occasional reactions from the contrast medium itself have been reported. Severe cough prevents a satisfactory bronchogram since the oil may be forced from the smaller bronchi into the alveoli obscuring the fields where bronchial visualization is important. Many thoracic surgeons object to bronchography in carcinoma of the lung because they feel surgery should be delayed for a period of six weeks or more after the use of iodized oil. Such a period of waiting allows further increase in size of the tumor.

Without contrast medium the bronchi are usually poorly visualized in the ordinary chest roentgenogram. A method of "air bronchography" has been described by some authors[4] and has proved quite successful in certain cases. The detail, however, is rather poor and in this country has not been widely used. The use of the Potter-Bucky diaphragm will assist in delineating the larger bronchi but the results are often unsatisfactory.

For the delineation of the bronchi, without the use of iodized oil, the roentgen method designated by Moore[8] as body section roentgenography, and variously called

planigraphy, tomography and laminagraphy, has been found to be most useful. Its utilization has increased accordingly despite its rather time-consuming, expensive technique. The history, principles, and details of the procedure have already been described repeatedly by various authors[1,5,8] and need not be dealt with in this paper.

Body section roentgenography has been used with considerable success by a number of investigators for the diagnosis of many portions of the body but most especially in pulmonary conditions. Moore[8,9] used it successfully in the diagnosis of lesions in the skull, spine and lungs. McDougall[7] recorded the efficacy of the method in many areas of the body including the bronchial tree system. Lowry and Rigler[6] demonstrated the actual tumor shadow within the bronchus in 7 cases of bronchial adenoma by means of planigraphy. Greineder[4] published a review of his method of use of planigraphy in the diagnosis of bronchogenic carcinoma in which he described the "tumor-core" shadow. Frimann-Dahl[3] published a series of 56 cases of bronchogenic carcinoma in which he demonstrated positive findings in 46 cases by means of planigraphy. He claimed the method was at least as accurate as were other methods of diagnosis while it possessed the advantage of a minimum degree of disturbance to the patient and there were almost no contraindications.

The technique of body section roentgenography is quite simple after a knowledge of the basic principles has been acquired. In our clinic, the equipment permits planigraphic study only in the recumbent position. It is obvious that films in the upright position would prove quite useful in certain cases especially where it is desired to demonstrate fluid levels within cavities. A special planigraphic attachment is used which allows the film holder with Potter-Bucky diaphragm and the roentgen tube to move in opposite directions in one plane around a point of rotation which represents the desired plane of the object. The depth of the layer may be changed by altering the point of rotation on the moving arm. The roentgen tube rotates so that the central ray always passes through the focal point in the desired plane.

A trial exposure is made usually at about 10 cm. from the table top with the patient in the supine position. Corrections are then made for exposure and positioning. It is our experience that underexposure is one of the commonest errors in technique. Enough exposure should be given to obtain the proper density of the bronchus when compared with the surrounding areas. The movement of the tube is such as to produce fairly thick sections. Films are taken at 8, 10 and 12 cm. from the table top. Two additional films are then made 1 cm. anterior and 1 cm. posterior to the level giving the most information about the lesion. There are then three films available for examination of the abnormality.

The planes in which films are made should parallel that of the involved bronchus as closely as possible. Films taken in a plane which passes in an oblique direction through the bronchus will produce an appearance of an abrupt ending to the shadow of the bronchial lumen thus simulating bronchostenosis. If the films in the next anterior and posterior positions are examined, however, the continuation of the bronchus will be noted and prevent an error in interpretation (Fig. 1 and 5).

In order to obtain parallel plane films it will be necessary, in some cases, to take lateral or oblique views in respect to the patient's body. Our experience has been largely with anteroposterior views so that the value of other projections has not been clearly ascertained.

The demonstration of an actual defect within the bronchus is the most helpful finding in bronchial tumors (Fig. 2). This is seen usually as a smaller tumor mass of greater density projecting into the air-filled bronchial lumen of lesser density. The lesion may project from one bronchial wall into the lumen or it may completely surround the lumen (Fig. 3). There may be an irregular, elongated stenosis of the bronchus

producing a "rat-tail" deformity (Fig. 4). In these cases, atelectasis is a prominent feature.

The demonstration of a peribronchial or extrabronchial mass is of considerable importance particularly in cases wherein there is some difficulty in delineating the intrabronchial lesion itself (Fig. 5). The presence of atelectasis, in addition to the mass, lends supporting evidence in favor of carcinoma even though an obvious intrabronchial mass cannot be seen. The size and position of the extrabronchial lesion is of considerable help in determining the prognosis and operability of the carcinoma. The mass is due to extension through the bronchial wall into the peribronchial structures or to extensive involvement of the lymph nodes.

The visualization of a clear cut intrabronchial mass is far more common in the benign adenoma or mixed tumor of the bronchus than in carcinoma.[6] In the malignant lesion inflammation, necrosis and

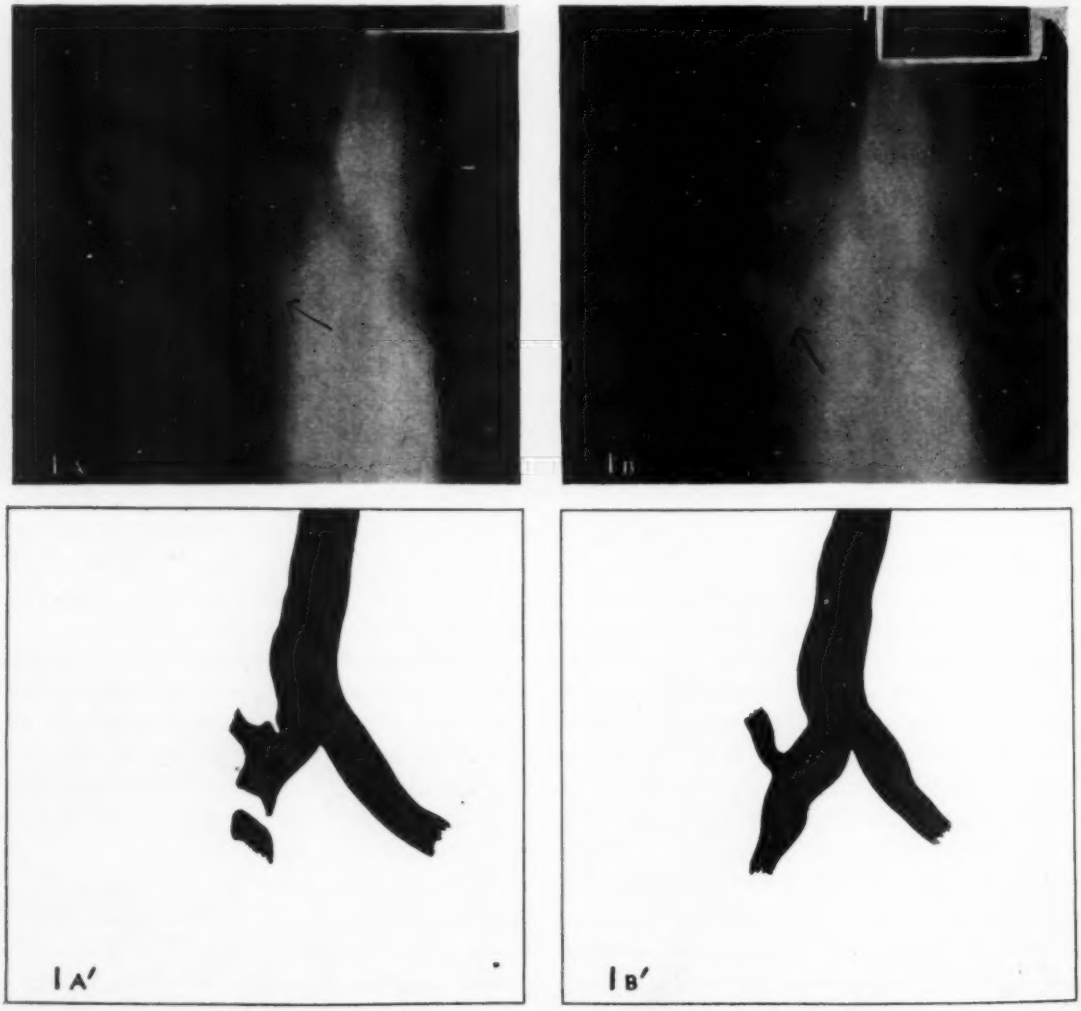

FIG. 1. Planigrams of trachea and bronchi. *A*, section 9 cm. from posterior wall. Note the clear delinetaion of the trachea, main bronchi and right upper lobe bronchus. The right lower lobe bronchus seems to end in an abrupt triangular shadow (arrow) characteristic of stenosis. *A′*, diagram from a tracing of *A*. *B*, section 10 cm. from posterior wall. The intact lumen of the right lower lobe bronchus is here visible. The enlarged peribronchial lymph nodes caused some angulation producing the appearance of stenosis seen in the more posterior section (*A*). *B′*, diagram from a tracing of *B*.

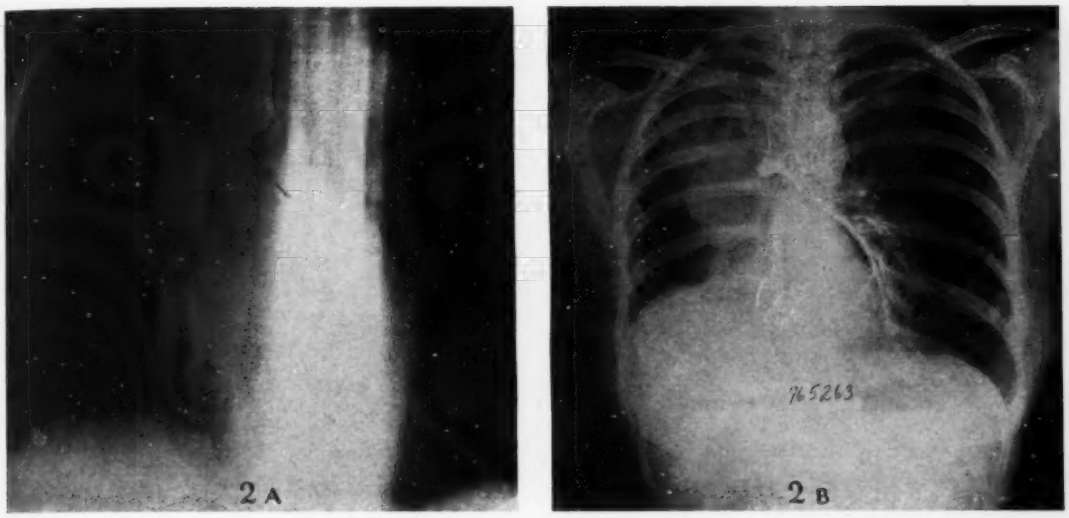

Fig. 2. Carcinoma right upper lobe bronchus. *A*, planigram showing abrupt termination of bronchial airway with a mass of greater density protruding into the bronchial lumen at its end (medial arrow). The peribronchial mass is also sharply outlined (lateral arrow). *B*, bronchogram in the same case. Note the striking similarity of the findings. With the iodized oil in the bronchus the tumor produces a defect in the outline rather than a positive shadow as in the planigram.

deep infiltration occur rapidly. As a result there is stenosis of the bronchus so that the air column around the tumor which is so obvious in the benign lesion is lost. There is, therefore, less contrast available in the malignant lesions. The demonstration of a clear column of air almost surrounding the tumor shadow should suggest that the growth may be benign.

On the other hand, the demonstration of a complete or partial stenosis of the bronchus is not sufficient in itself to indicate a diagnosis of carcinoma since inflammatory lesions will also produce narrowing of the bronchial lumen. The distinction between an inflammatory and a neoplastic stenosis is also not easy in the bronchogram. The presence of the typical "rat-tail" deformity or of an irregular elongated narrowing of the bronchus is characteristic. Nevertheless the collateral evidences afforded by the other lung changes, the history and laboratory findings are needed to make sure of the diagnosis if biopsy is not available.

Essentially, planigraphy serves as a supplement to or substitute for bronchography. In many situations an equally good picture of the major bronchi may be obtained by this means (Fig. 2). In some cases the planigraphic method produces a more graphic demonstration of the tumor itself or of the bronchostenosis than can be obtained by bronchography (Fig. 4).

Just as in bronchography, it is possible by body section roentgenography to demonstrate many of the bronchi so that the presence or absence of other invasion or extension into other bronchi may be observed. An intact lower lobe bronchus in a patient with a carcinoma of the right upper lobe bronchus is illustrated in Figure 3. The contrary is shown in Figure 6 in which the primary lesion in the right upper lobe bronchus as well as an extension in the lower lobe bronchus can be readily seen. For this purpose, also, films in several planes must be examined in order to delineate the various branches (Fig. 7).

Since the introduction of planigraphy in this clinic it has been used on 181 patients suspected of pulmonary disease. In 81 of this series there was no thought of a lung tumor, most of them being cases of tuberculosis or other inflammatory diseases in which it was desired to determine the presence of cavities or other details of the anatomy. One hundred cases were examined because of suspected tumor and in

FIG. 3. Carcinoma of right upper lobe bronchus, planigram. The right main bronchus is well delineated. The upper lobe branch is seen to be completely occluded (upper arrow) by a surrounding mass. The lower lobe bronchus (lower arrow) is clearly outlined and does not appear to be invaded or constricted.

47 of these a bronchial neoplasm was eventually found by one method or another. Several hundred other cases were examined during this period of time for suspected tumor and many more lung tumors than the above 47 were seen. The remaining were not subjected to planigraphic study because the diagnosis was obvious without the need of special procedures, or had been proved by some other procedure, or the patient was too ill to be moved to the roentgen department or for many other reasons. It should be noted that for a period of several years a potent force militating against the use of planigraphy was the severe shortage of roentgen film.

Among the 47 recorded bronchial tumors in which planigraphy was used there were 10 of the so-called bronchial adenoma type, all apparently benign as indicated by their history, course, and histopathologic examination. Seven of these have already been reported.[6] The remaining 37 were bronchial carcinomas as indicated by the collateral findings. In all but 9 of these the diagnosis was proved by microscopic examination of the tissue. In the latter cases the other findings and the course of events were so characteristic as to leave no doubt as to the diagnosis.

The 47 patients with bronchial tumors were submitted to a number of procedures

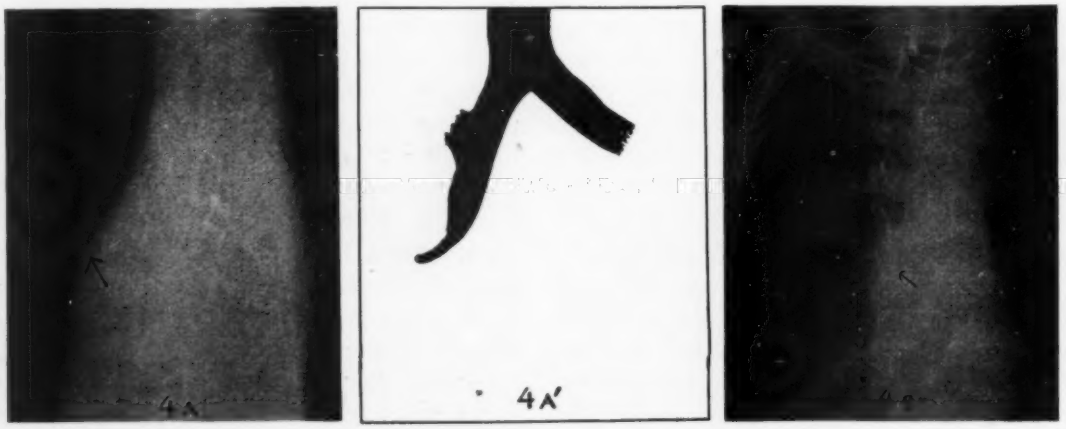

FIG. 4. Carcinoma of right stem bronchus. *A*, planigram showing elongated, irregular stenosis (arrow) with air column extending into the mass. The "rat-tail" appearance is well shown. *A'*, diagram from a tracing of *A*. *B*, bronchogram in the same case. The stenosis of the bronchus is well demonstrated by the iodized oil column (arrow). Note that the air column shown in the planigram (*A*, *A'*) extends to a point distal to the end of the iodized oil column. Thus, occasionally, planigraphy gives a more faithful reproduction of the pathological anatomy than does bronchography. The atelectasis of the middle and lower lobes and the emphysema of the upper lobe are also seen.

Table I

	No. of Cases Examined	Successful Demonstration of Tumor	Per Cent	Unsuccessful Demonstration	Per Cent
Planigraphy	47	42	89	5	11
Bronchography	19	18	95	1	5
Bronchoscopy	33	28	85	5	15

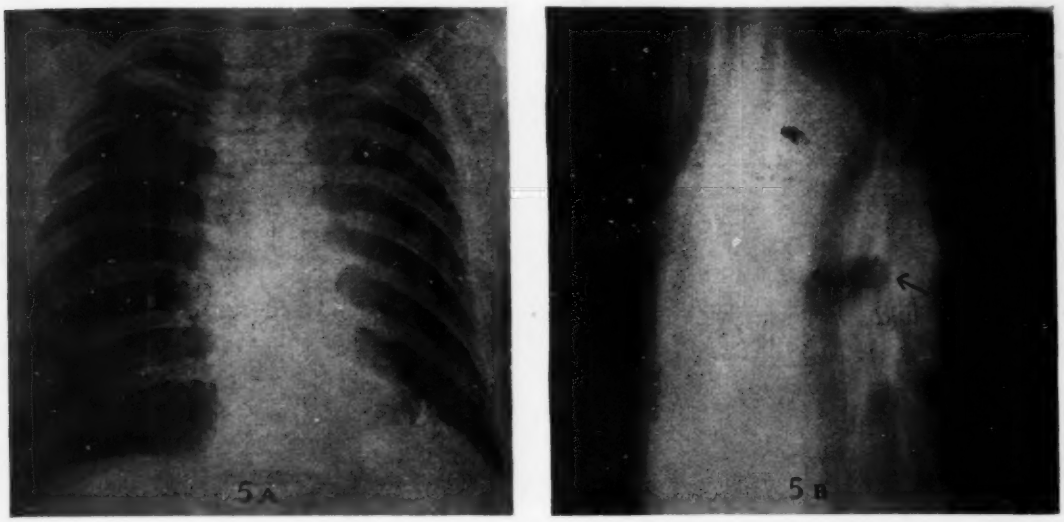

Fig. 5. Carcinoma of left upper lobe bronchus. *A*, posteroanterior roentgenogram exhibiting atelectasis of left upper lobe. The mass in the hilum is not clearly demarcated. *B*, planigram of same case 12 cm. from posterior chest wall. Note the abrupt ending of the air column of the left main bronchus (arrow). The lower lobe bronchus was seen to be fully patent in other films made in a more posterior plane. The deceptive appearance of an angulated bronchus is again shown in this planigram. In addition the large mass in the hilum is clearly delineated adding further evidence of the neoplastic nature of the obstruction.

for diagnosis and the results achieved are indicated in Table 1.

It is evident at once that this is a selected group of cases and it is not intended that these figures should serve as any indication of the relative value of the designated methods. As in all diagnoses of chest dis-

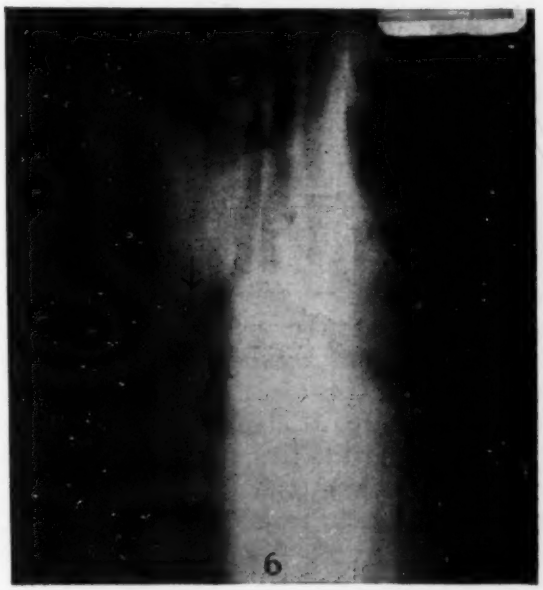

Fig. 6. Carcinoma of the right upper lobe bronchus, planigram 8 cm. from the posterior chest wall. Note the characteristic irregular constriction of the upper lobe bronchus (upper arrow) which was better demonstrated in a more anterior plane. The lower lobe bronchus is clearly delineated and a typical infiltration and narrowing of its lumen (lower arrow) is apparent. There was involvement of the peribronchial lymph nodes with extension into the lower lobe bronchus.

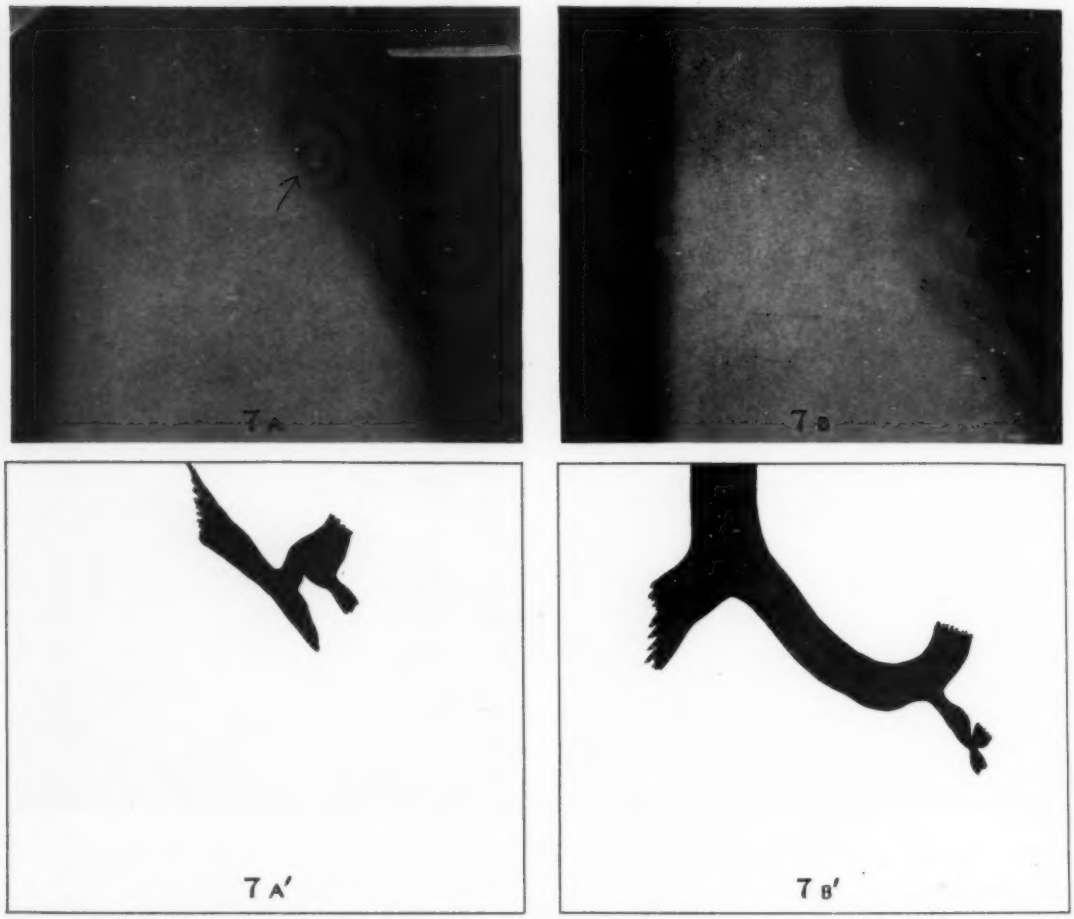

FIG. 7. Carcinoma of the left lower lobe bronchus. *A*, planigram 11 cm. from posterior chest wall. The left main bronchus and its branches are demonstrated. The lower lobe branch (medial arrow) is seen to be stenosed in fairly irregular fashion. The upper lobe bronchus and its lingular branch (lateral arrow) are not so clearly delineated. *A'*, diagram from a tracing of *A*. Both the stenotic lower lobe branch and the upper lobe branches are shown. *B*, planigram at 12 cm. level. The upper lobe bronchus is well shown and the lingular branch (arrow) is especially clear. At this level the lower lobe branch cannot be observed. The intact upper lobe bronchi are thus delineated in one section while the stenotic lower lobe bronchus is seen in another section. *B'*, diagram from a tracing of *B*. Only the left main bronchus and its upper lobe branches are shown.

eases certain procedures are more applicable to certain cases. Selection of an adequate procedure must always be individualized. The purpose of these figures is only to indicate the possibilities of planigraphy as a supplementary or substitute method in certain cases.

The procedure of planigraphy was a failure in 5 cases the details of which are as follows: Coughing and dyspnea were sufficiently severe in 1 case to prevent proper cooperation. In another there was a pneumothorax present with a considerable collapse of the lung and distortion of the bronchus. In a third case, the lesion was in the bronchus to the anteroinferior segment of the upper lobe. In the latter 2 patients the tumor was demonstrated by means of bronchography. In 2 additional cases underexposure prevented satisfactory visualization of the bronchi involved.

In many of the cases in which only a branch bronchus was obstructed, a mass could also be seen extending into the main bronchus from which the obstructed bronchus arose. The masses in these cases were

not sufficiently large nor did they extend far enough to obstruct other branch bronchi.

An interesting observation was the presence of good aeration in certain portions of the lung beyond what appeared to be a complete obstruction. The probable reason for this phenomenon is that deep inspiration allows the passage of air in one direction through a very constricted lumen. A somewhat similar situation is that of a partially aerated lobe, with segmental atelectasis, beyond what appears to be a complete obstruction of the main bronchus to that lobe. An explanation, somewhat questionable, has been made that there is collateral aeration through the interlobar fissure from the adjacent uninvolved lobe.

By means of bronchoscopy, tumors were demonstrated in 28 of the 33 cases in which it was used. Of the 5 failures, 3 were in patients with lesions of the lower lobe bronchi, 2 of them on the left; 2 were in the upper lobe bronchi, 1 on each side. In 3 of these cases the defect was successfully demonstrated by both bronchography and planigraphy; in one it was delineated by planigraphy, in the other by bronchography.

Bronchography was possible in 19 cases and successful in 18 of the total with only 1 failure. The failure was in a patient who was coughing severely. The small number of cases submitted to bronchography indicates the high percentage of patients in whom the examination was found to be inadvisable or impractical or in which planigraphy had proved to be an adequate substitute.

The various bronchi in which tumor or obstruction were demonstrated by planigraphy are indicated in Table II.

The 5 cases in which planigraphy was unsuccessful had tumors in the following regions:

Right main bronchus	3
Left upper lobe bronchus	1
Right lower lobe bronchus	1

SUMMARY AND CONCLUSIONS

Planigraphy has demonstrated its effectiveness as an aid in the diagnosis of intrabronchial masses. It is not intended to replace the older methods of diagnosis, which are still extremely useful and in certain cases more accurate, but it represents an adequate supplementary and substitute procedure.

Its accuracy compares favorably with other roentgen methods of diagnosis. It offers great advantages in the lack of complications and contraindications which affect other types of examination such as bronchography and bronchoscopy. It can be used in many cases in which other methods are impossible.

Certain details concerning the technique used in this clinic have been given in the hope that slight aid may be offered to those contemplating the use of this procedure. If certain general principles are followed satisfactory results can be obtained.

A report of 47 patients with bronchial tumors in which planigraphic studies were made is presented and illustrative cases are detailed.

A total of 47 cases were examined by planigraphy and failures were noted in only 5 cases. Experience with the procedure will reduce the number of failures appreciably. Bronchography failed in only 1 of the 19 cases examined but it is noted that in many cases this method could not be used.

If continued progress in improving the

Table II

PLANIGRAPHIC DELINEATION OF BRONCHIAL TUMORS—42 CASES

Right		Left	
Multiple bronchi	3	Multiple bronchi	3
Main bronchus	2	Main bronchus	3
Upper lobe bronchus	8	Upper lobe bronchus	4
Lower lobe bronchus	12	Lower lobe bronchus	4
Middle lobe bronchus	2		
Middle and lower lobe	1		

technique of planigraphy is maintained it may reduce the importance of other methods of examination of the bronchi.

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DISCUSSION

DR. SHERWOOD MOORE, St. Louis, Missouri. This paper is of such excellence that very little discussion is called for. It is very timely and all that I can contribute, if anything, is commendation and a few details regarding methods.

In our clinic, carcinoma of the lower respiratory tract is exceedingly common. I do not know the relative percentage, but it is very high and I am convinced that carcinoma of the lower respiratory tract is actually on the increase.

That fact calls for the best diagnostic effort of every radiologist. It also indicates that the most refined methods which we are capable of using should be employed. My recollection is that 75 per cent of the cases of bronchogenic carcinoma in our clinic are hopeless and virtually terminal by the time they reach us.

Therefore, any method which will increase our accuracy of diagnosis before that late stage has arrived is to be employed. I do not believe that the cost of doing this work resides so much in the films, an objection which I have frequently heard at our meetings—it isn't the film that costs, but rather it is the labor because this procedure requires much time, and the more accurately it is done the more time is required.

As Dr. Rigler said, it is a supplemental type of examination and should always be preceded, of course, by conventional roentgen examinations. I do not believe it should be resorted to (where indicated) before bronchography or bronchoscopy is done.

Any one of you can learn from any of a number of publications how to build the so-called home-made planigraph or whatever you choose to call it. I constructed one myself at a cost of fifteen dollars, and it did excellent work. I prefer to use the more elaborate apparatus because it gives better results.

As for details of methods, one should have enough sections to be sure that one is not being deceived by a change of depth of focus, which Dr. Rigler has so beautifully demonstrated in the bronchus angulating and turning out of the plane of focus. The depth of focus is of the order of one centimeter. The conventional films, especially the lateral, determine the distance of the suspected area from the posterior or anterior thoracic wall. The patient is placed supine or prone, depending on which will bring the suspected area nearest to the film.

Where there is no guide, several films at 1 cm. depths should be made, as Dr. Rigler has shown; several from the midline to the posterior wall, and several in the opposite direction.

This is an extremely helpful method, particularly in the upper sections of the lungs where, as Dr. Rigler has pointed out, bronchoscopy with biopsy is difficult and often impossible, and where bronchography also frequently fails.

BENIGN PNEUMOCONIOSIS DUE TO METAL FUMES AND DUSTS*

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THE term "pneumoconiosis," first used by Zenker[8] in 1867, requires redefinition because it is so widely misunderstood. Its generic meaning simply is "dust added to the lungs," without any implication of what reaction may or may not have resulted from the dust. Only two dusts are known to cause significant fibrotic reactions in the lungs: free silica and asbestos. However, because silicosis and asbestosis are the best known pneumoconioses, the terms "fibrosis" and "pneumoconiosis" unfortunately have become almost synonymous in many medical minds.

The benign pneumoconioses, therefore, are those resulting from inert dust deposits in the lungs, which are not the cause of any fibrosis or disability. Siderosis is one of these, as shown in the case reported by Enzer and myself[2] in 1938, in which a tank welder who showed roentgen changes simulating silicosis had no fibrous tissue in the lungs when studied at postmortem. The roentgen shadows simulating silicosis were shown to be due to aggregations of radiopaque iron particles in the lymphatic channels and nodes surrounding the blood vessels and bronchi.

These findings differ from Zenker's original description of siderosis, in which he implied that the iron dust inhaled into the lungs was the cause of the associated fibrosis. This early concept is understandable when his reported cases are analyzed, each actually having fibrosis not due to iron, however, but to associated tuberculosis or silicosis. Also, later pathological reports of siderosis in iron miners' lungs usually were cases of sidero-silicosis, the observers erroneously concluding that the iron was the cause of the fibrosis rather than the silica. The term "siderosis," therefore, is a perfectly proper one to use for this type of benign pneumoconiosis, provided the implication of fibrosis is excluded.

A number of different occupations appear to have been responsible for the development of siderosis besides the electric welding described by us. It was with surveys of hematite iron ore miners in England that it was first suspected that the hematite itself might be casting some of the shadows seen on the roentgenogram. A radiologist named Thurstan Holland is quoted by Fawcitt[4] as first suggesting this possibility as early as 1919, but it was doubted by Collis and others because of the solubility of the iron oxides. Fawcitt, however, cites a postmortem study of a hematite miner made in 1936, in which "no undue fibrosis was found," but aggregations of hematite particles in the lung lymphatics were believed responsible for the "snowflake mottling" seen in the roentgenogram.

More recent postmortem proof that iron oxide particles may form aggregates in the lung lymphatics is offered by McLaughlin, Grout, Barrie and Harding,[6] also of England. Their case was a man, aged fifty-four, who had been a silver polisher for forty years in which work "rouge" (Fe_2O_3) is used as the abrasive. Their microscopic sections resembled in every detail those reported by us in the electric welder in 1938, including a complete absence of fibrosis. The roentgenogram also resembled the discrete stippling seen in our electric welders. Other similar cases among silver polishers were cited as showing the same roentgen appearances, which they attributed largely to siderosis.

Hamlin[5] recently described similar roentgen changes in foundry grinders and burners, in which the silica exposure had been insufficient to account for the nodulation seen on their roentgenograms. The iron

* Presented at the Forty-seventh Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 17–20, 1946.

oxide exposure, however, had been sufficiently high to warrant the conclusion that their nodulation was due largely to iron collections in the lymphatics. Unfortunately, the opportunity for postmortem proof in these cases has so far not presented itself. Pendergrass and Leopold[7] have reported 4 suspected siderosis cases in metal grinders in which they had evidence by an engineering study of insufficient exposure to free silica dust to warrant a diagnosis of silicosis. Another occupation presenting similar exposure factors and roentgen appearances is that of boiler scaling, recently reported in England by Dunner,[1] but postmortem proof also is lacking here.

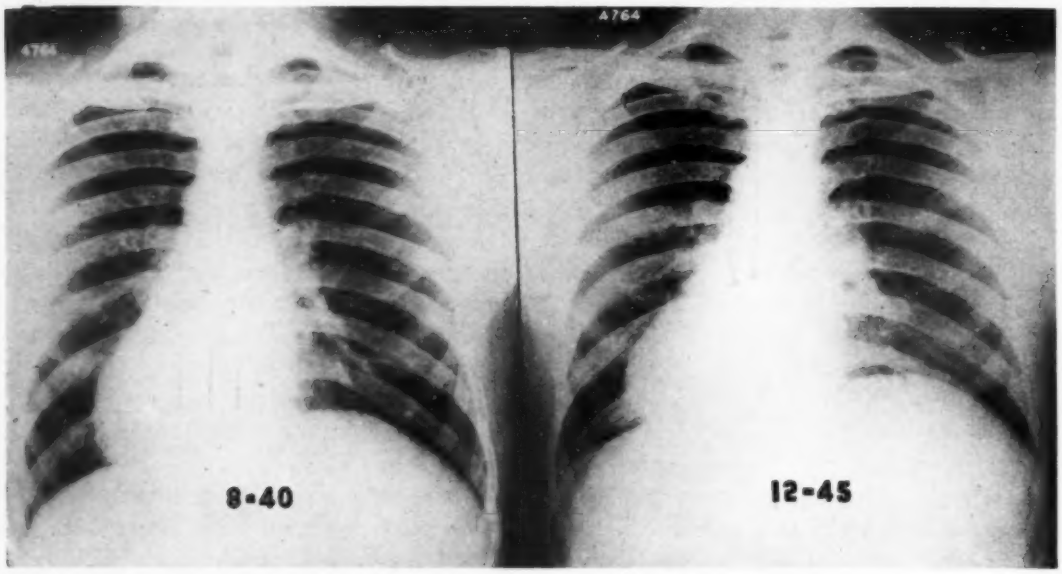

FIG. 1. Case. 1.

I should like to add to this growing list of occupations which may be siderosis producers that of metal cutting with the oxyacetylene flame. In our roentgen surveys of foundry workers dating back to 1933, we were at a loss to explain why these gas cutters working in the foundry cleaning rooms developed nodular silicosis more rapidly than did other employees in the same room. We at one time suspected that the heat of the flame might be volatilizing some of the adhering molding sand, and therefore urged that the castings be more thoroughly cleaned before the cutting operation. We did not realize until after our electric welder study that the fumes released during the gas cutting of metal contains the same oxides of the metal being cut as with electric welding and that these are in extremely fine particulate dispersion (less than 0.5 micron) and in extremely dense concentrations (upwards of 100 million particles per cu. ft.). Although these cutters were known to be inhaling some free silica dust which is present in varying degrees in all foundry cleaning rooms, the silica exposures were too low to account for the nodulation which was appearing in from six to eight years of this work. We now believe that the nodulation in many of these cases is largely due to siderosis, with little if any associated silicosis. Only a few which appear most representative will be reported here.

REPORT OF CASES

CASE 1. L. P., aged thirty-five. Oxyacetylene cutter in steel foundry cleaning room since 1933. No previous dust or fume exposure. Chest roentgenogram still clear in 1940 after seven years of exposure, but gradual development of discrete nodulation or stippling since then. Silica exposure slight, but fume exposure heavy during past five years of increased war production. Has no symptoms of any kind and physi-

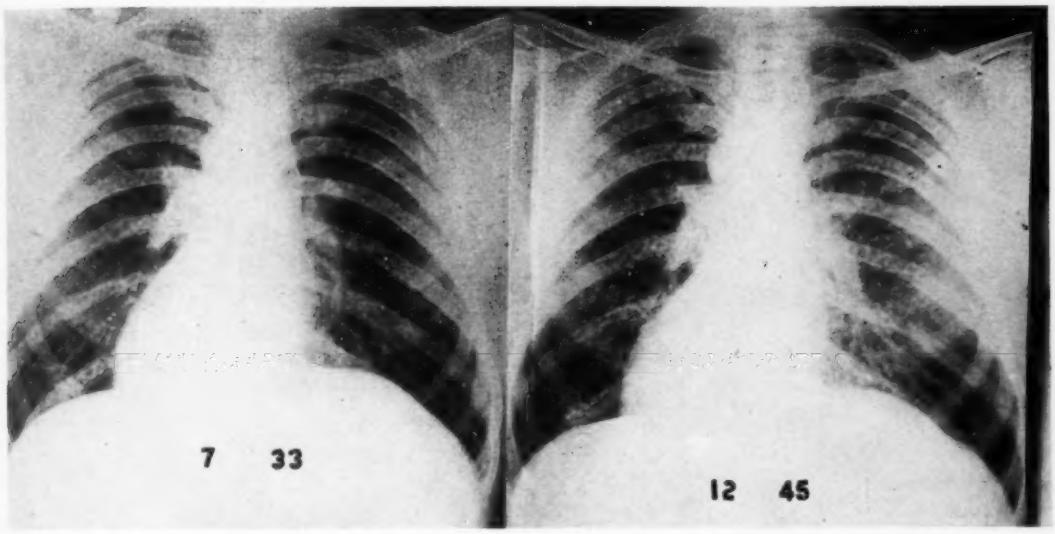

Fig. 2. Case II.

cal findings negative. Will continue at regular work.

Case II. H. O., aged fifty-seven. Oxyacetylene cutter in steel foundry cleaning room for past twenty-four years. No previous dust or fume exposure. Chest roentgenogram in 1933, after twelve years of exposure, shows early discrete nodulation. This has increased only slightly in past twelve years. No symptoms or physical findings in chest. Will continue at regular work.

Case III. J. S., aged thirty-two. Oxyacetylene cutter in steel foundry cleaning room for ten years (began 1934). Clear lungs to January, 1943, after nine years of exposure, followed by gradual development of discrete nodulation or stippling. Had attack of "flu" or pneumonia in January, 1944, but precise diagnosis not made and was not roentgenographed then. Next film in March, 1944 (Fig. 4), showed marked enlargement of root lymph nodes, with persisting dyspnea and cough. Symptoms gradually subsided during next six months and root nodes

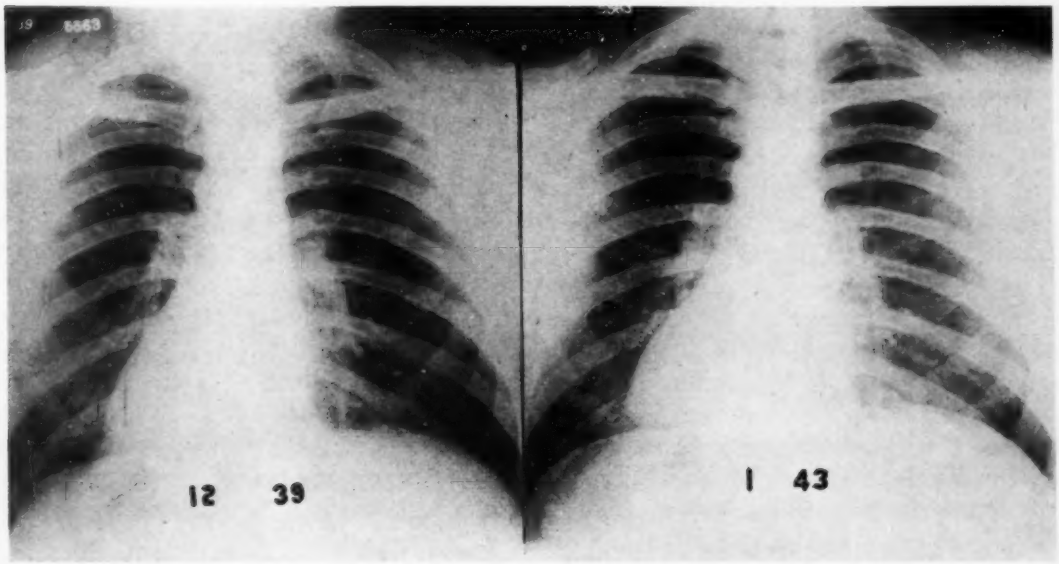

Fig. 3. Case III.

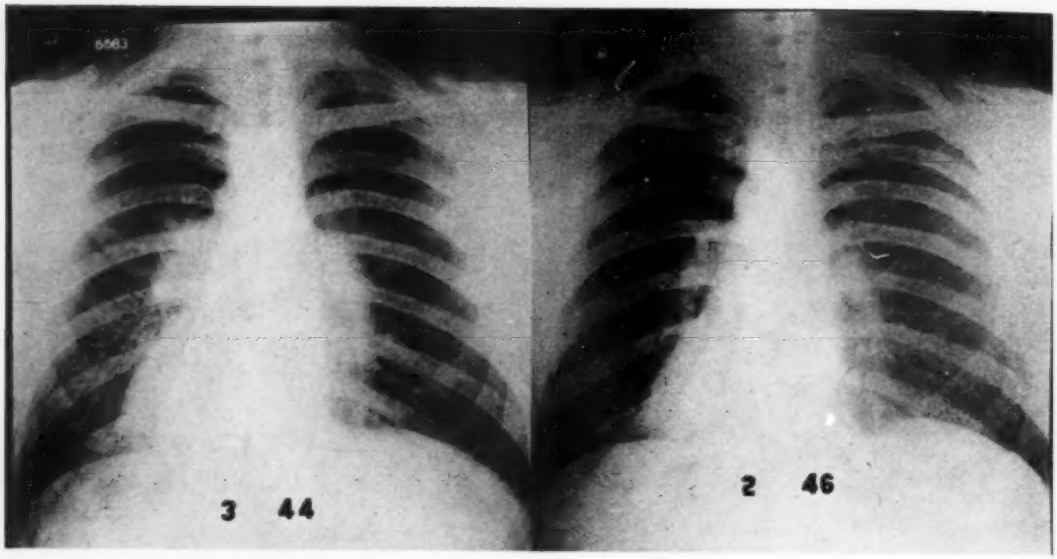

FIG. 4. Case III.

gradually returned to normal size. Has no symptoms now and is working daily. Generalized nodulation or stippling continues.

These 3 cases have the following diagnostic points in common, which are similar in every way to those described for the electric arc welders:

1. Discrete and rather sharply defined rounded shadows, of more or less uniform size and equal distribution in both lungs.
2. No tendency to confluence of the shadows.
3. Hilum shadows always smaller than would be expected with silicosis of this degree (except during infections).

We have not seen any of these cutters with associated progressive tuberculosis, which is further evidence that they are primarily siderosis cases with little or no silicosis. Non-tuberculous infections, as suggested by the probable pneumonitis and lymphadenitis of Case III, also appear to clear up completely, indicating no obstruction of the lymphatic circulation. Moreover, there has been a complete absence of symptoms with all of these cases, except during episodes of acute infections. Even with our electric welders with rather marked roentgen changes, there has been no measurable impairment of lung function.[3]

So far there has not been an opportunity for postmortem study of any of these cutters. Some of them may have some silicotic nodulation in addition to the iron pigmentation but, for the reasons given, we believe that their roentgen shadows are due primarily to the aggregations of radiopaque iron particles in the pulmonary lymphatics surrounding blood vessels and bronchi.

In closing, I should like to make a plea to all physicians to be on the alert for more postmortem studies of cases showing nodular roentgen-ray patterns. Too few have been adequately analyzed and the findings correlated with the roentgen appearance. Too often, also, gross black pigmentation at postmortem has been erroneously diagnosed as anthracotic, when ferrocyanide stain of the sections would have made the differential diagnosis by revealing the Prussian blue reaction for iron. Gross round lesions also have been incorrectly diagnosed as silicotic without use of the connective tissue stains to determine if they were true fibrotic nodules. These differential procedures are recommended with all cases showing nodular or stippled roentgen shadows.

Finally, more careful analysis of past dust exposures is recommended whenever

a roentgenogram showing nodular shadows presents itself for an opinion. It is not enough to obtain a history of foundry work, mining, or grinding. The precise environmental conditions must be determined, which frequently requires sampling of the atmospheric dust and its detailed analysis by an expert industrial hygienist. "Pneumoconiosis" alone no longer can be considered an adequate diagnosis because the benign pneumoconioses must be differentiated from those which may be disabling and progressive. All that is nodular by roentgen-ray is by no means silicosis and we owe it to labor and industry alike to prevent unfortunate mistaken diagnoses which always are so upsetting to all concerned.

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DISCUSSION

Dr. Philip J. Hodes, Philadelphia, Pa. Dr. Potter was to have discussed Dr. Sander's paper, but is ill. Having been drafted but a few moments ago, I cannot bring to this discussion the studied consideration it merits.

Dr. Sander's report is timely and important. It is timely because of the new techniques being developed by industry for handling metals, organic solids, liquids and gases; some of which are potentially dangerous to employees. It is important because it throws considerable light upon the bronchopulmonary complications which he recognized in workers exposed to metal fumes and dusts.

Not many years ago, men interested in pneumoconiosis believed that the small nodules described in classical silicosis were found only in individuals exposed to silicon dioxide, SiO_2. Though unable to explain the appearance of "silicotic nodules" in men with no known exposure to silica, the presence of silica was usually postulated in order to explain the roentgen findings.

Evidence gradually accumulated, however, that seemed to indicate that among other industries, barium workers, iron workers and even cotton workers developed bronchopulmonary changes similar to those thought previously characteristic of silicosis. Now Dr. Sander tells us similar pulmonary nodulations may be found in workers in metal fumes and dusts. His illustrations leave no room for doubt.

I am impressed by several features in the latter. First, Dr. Sander did not show us any roentgenograms in which pulmonary fibrosis of the type seen in silicosis was evident. Indeed Dr. Sander feels pulmonary fibrosis is not part of this picture. This is extremely important because of its bearing upon prognosis. It is probably too soon to be sure that these patients will not go on to develop massive pulmonary consolidation.

Second, it seemed to me that the pulmonary nodules seen in these metal fume workers were a little smaller and more clear-cut than the nodules seen in silicosis. I would hesitate to try to differentiate the two, however, on this evidence alone.

It is obvious that no roentgenologist could hope to offer an etiologic diagnosis in these patients without an adequate occupational history. No index of suspicion could possibly be high enough to make this diagnosis based solely upon the films of the chest. This is but another example of the interdependence of clinician and roentgenologist. Cases like these will go unrecognized unless the roentgenologist sees his patients personally and seeks help from his consultants constantly.

I have two questions to ask of Dr. Sander.

First, does he have any information concerning the gaseous exchange in the lungs of these patients? Second, have any of these cases yet come to litigation?

May I take this opportunity to congratulate the essayist upon the excellence of his presentation and thank him for sharing this important information with us.

DR. FREDERIC E. TEMPLETON, Seattle, Wash. In listening to these papers, it appears to me that we are confusing the issue by trying to make a microscopic and chemical diagnosis from a roentgenogram. There are many substances which cause these conditions in the lungs. At Cleveland, we encountered beryllium. There was the nitrous oxide poisoning at the Cleveland fire. There is iron and silicosis. When we look at a neoplasm, we cannot always make a microscopic diagnosis.

I wonder if we cannot simplify the problem by throwing all these conditions into one group, chemical pneumonitis, if you please. From there on the definition is a clinical problem.

DR. L. G. RIGLER, Minneapolis, Minn. I wasn't going to discuss Dr. Sander's paper but Dr. Templeton touched me on a very raw spot. We do make the diagnosis of tumors from roentgen examination very frequently and we are very frequently right, and I see no reason why we should adopt a defeatist attitude about that or anything else simply because we cannot always be right.

That is the implication of saying "This is a spot on the lung" rather than saying what we think it is. Obviously, there have to be certain limitations and we have to recognize them but I wouldn't accept the idea that we should refrain from making microscopic diagnoses because it would be a sad mistake if we did.

I would like to ask Dr. Sander a question in relation to this. It has appealed to me since some contact with arc welders awakened me to this particular problem. That is with regard to the matter of benignity of the lesion. Waldenstrom, and others,—and we have seen one or two cases ourselves—have reported cases of what he called hemosiderosis pulmonum. That is in relation to sideropenic anemia, there is bleeding from the lungs from time to time over a period of years producing a hemosiderin deposit.

I realize this is a very different kind of iron, and it is deposited in the alveoli. Nevertheless, it was found that it was just iron and these patients die of suffocation from fibrosis. There isn't much doubt about that, as shown at autopsy examination.

I am not sure it is comparable and I would be glad to hear Dr. Sander discuss that. I am wondering whether we are justified in assuming the benignity of this finding in light of the fact that all of us see real silicosis with nodulation, in which the patients are entirely symptom free and if we didn't follow them long enough or if the exposure didn't continue, we would consider the lesion also entirely benign.

I wonder if we have had enough experience with siderosis to draw the conclusion that it is a benign dust.

DR. SANDER (closing). The only physiological studies which have been made of welders showing these deposits were reported in 1945 by Enzer and his co-workers at Mount Sinai Hospital in Milwaukee, in which they included 15 welders showing these changes, with a control group of 15 foundry workers with definite nodular silicosis and an additional control group of the same approximate age without any lung changes. Numerous tests were made which are too numerous to mention here, but the final result showed that the welders had completely normal response to these exercise tests, comparing favorably with those who were entirely free of any chest pathology, whereas those with silicosis showed a slight impairment of lung function.

The other evidence is that we have not seen any with symptoms and they are working daily without any impairment. I do not know that these lung changes have any status in the courts because I do not know that any have come to trial. I believe, however, that we have fairly convincing evidence that it is not a disabling condition at this time and it seems unlikely that any disability will result from these deposits in years to come.

On the question of hemosiderin, we have considered that possibility in these cases. Hemosiderin deposited in the alveoli in sufficient degree undoubtedly will cast shadows. But the iron in these welders is intracellular; i.e., within the phagocytes in the lymphatics of the lungs, and it does not stay in the alveoli. Furthermore, complete blood counts on all of our welders and cutters have not revealed any evidence of anemia.

Vol. 58, No. 3

SPONTANEOUS HEALING OF LOCALIZED HEMATOGENOUS SPREAD IN PULMONARY TUBERCULOSIS

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I

SPONTANEOUS healing of tuberculous changes disseminated in the lungs and associated with cavitation has been described in a previous paper[3] (1944). The patients concerned were in good general condition, apyrexial and devoid of physical signs. This "cavitation complex" was shown to be subject to healing by resolution, fibrosis or calcification. Changes which had some features in common with the cavitation complex were mentioned in cases of extrapulmonary tuberculosis by Miller[5] (1934), Reisner[8] (1934), and Tepper and Jacobson[11] (1934). Spread and cavity need not necessarily occur together. Spontaneous healing of a spread of the type described may occur alone. Twenty-five such cases form the subject of the present paper.

As a rule the history has no significant features and the disease was only discovered roentgenologically. General condition of the patient was reasonably good and physical signs, if at all present, were few. The lack of râles, even post-tussic, is of high diagnostic significance, as will be substantiated later.

The sputum contained tubercle bacilli, sometimes only detectable after repeated examinations.

Roentgen examination nearly always proves surprising, as it discloses a characteristic spread essentially identical with that found in the "cavitation complex," namely an evenly distributed rather closely packed spread, mainly of small sized foci, which seem to have developed simultaneously. Unlike cases of advanced phthisis, in which tuberculous patches are often discernible, indicating that one apparently older tuberculous area has conveyed some tuberculous material into an other, a tuberculous source in the lung cannot here be seen. The absence of such source of spread due to bronchogenic aspiration and the even distribution of the foci suggest hematogenous rather than bronchogenic origin, although it is, admittedly, not always possible to exclude such cavities or to differentiate roentgenologically between hematogenous and bronchogenic spread.

Larger patches observable in some patients among the small foci may be due to confluence of smaller foci, or may consist of a small tuberculous core with perifocal inflammation of which proof is afforded by Case VI, in which the first roentgenogram shows a spread with patches varying in size, while the second roentgenogram taken after seven months' rest reveals very distinctly evenly distributed small foci.

The extent of the spread varies: in some cases it is found only in one zone, in others in a whole lung field, while there are cases in which the upper zones of both lungs have been affected, or there may be even more extensive involvement.

Several patches of spread may occur at varying intervals in the same patient. An adjacent area may coalesce with the first one, or the second area may appear at some distance from the first one, or even in the other lung field.

The type of pulmonary tuberculosis described is marked out by its tendency to spontaneous healing which may take place as early as within six months, the longest interval observed in the present series being six years. It is permissible to assume complete healing when the roentgenological manifestations have disappeared and when numerous sputum tests have been found to be negative. Cough and sputum may still persist, however, for some time.

Such healing, as has been described, does, of course, not exclude further manifestations of tuberculosis from developing at a later date either in the lung or any other organ. In this connection it is worth mentioning that 2 patients in this group subsequently developed (but before the roentgenological manifestations had disappeared) a fatal meningitis. No necropsy was performed.

Not all cases of the type described heal spontaneously. Some deteriorate, as can be seen roentgenologically; clinically râles can be found which had not been audible at the time of the initial observation.

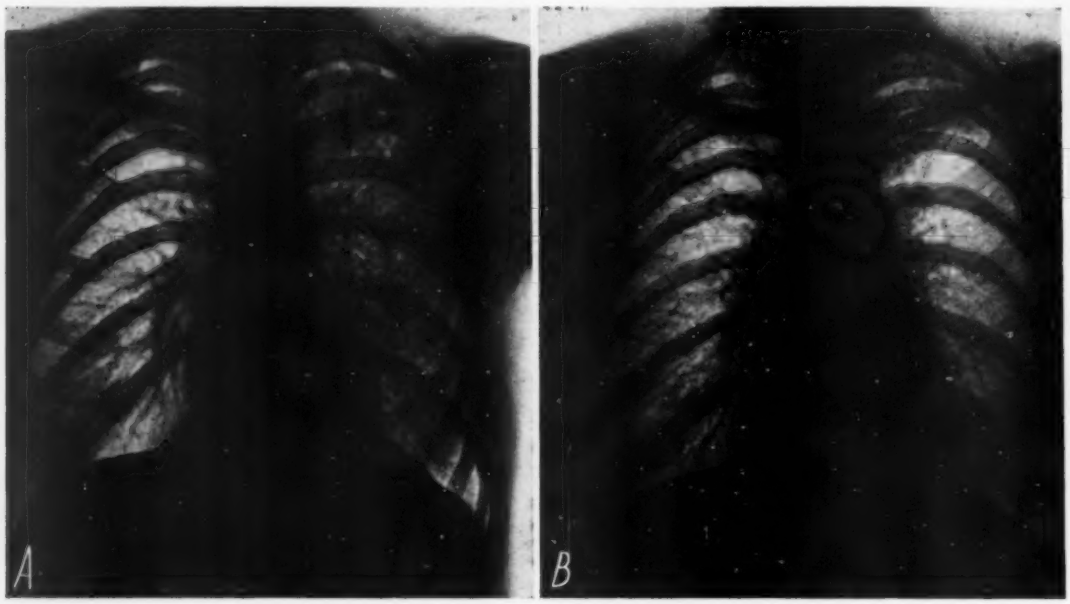

FIG. 1. Case 1. Vera D. *A*, May 20, 1943, uniform distribution of small foci in left upper and mid-zone *B*, June 21, 1944, resolution.

As to the nature of this type of pulmonary tuberculosis and its tendency to spontaneous healing the following tentative explanation may be submitted. The foci appear to be the result of a hematogenous spread into the interstitial tissue of the lung. As long as the spread is localized in the interstitial tissue, there are no râles which, if present, would indicate the contact of (tuberculous) material with air. When some sporadic foci penetrate into the alveolar and/or bronchial system, some sputum containing tubercle bacilli may be produced. Râles will not be audible, however, if this development is limited and/or situated in an area of the lung some distance from the chest wall. This assumption that the spread is limited to the interstitial tissue might perhaps account for the tendency to spontaneous healing. The presence of air has been thought to be favorable to the growth of tubercle bacilli and to the development of tuberculous tissue in the lung. The fact that the spread is localized in the interstitial tissue and thereby cut off from the air might be regarded as the cause of the promotion of healing. Similar conditions are likely to be predominant in chronic miliary tuberculosis which is known to be prone to spontaneous healing. The course of the disease in our group depends upon whether or not the spread remains limited to the interstitial tissue. If foci develop and penetrate *on a larger scale* into the air passages, râles can reasonably be expected.

It is advisable to distinguish between cases in which (post-tussic) râles are audible and those in which they are not. The former have not the same tendency to spontaneous healing as the latter. But a decision as to the presence or absence of râles should not be made before the patient has had a complete rest of about ten to twelve weeks, after which time any râles present may

have disappeared. It is important to make this distinction, for it has a practical bearing. It has been for many years the generally accepted opinion that most of these cases are suitable for active therapy, in particular artificial pneumothorax. By a fortunate chance the opportunity occurred to follow up cases of that group which had not been subjected to active therapy. Now having deterioration. On the other hand, when the patient gains weight, when cough and sputum decrease during the first three to four months of his stay in a sanatorium, a favorable view may be taken and a conservative attitude is justified. There is no necessity to detain the patient in a sanatorium until healing of the tuberculosis is definite. The duration of treatment and

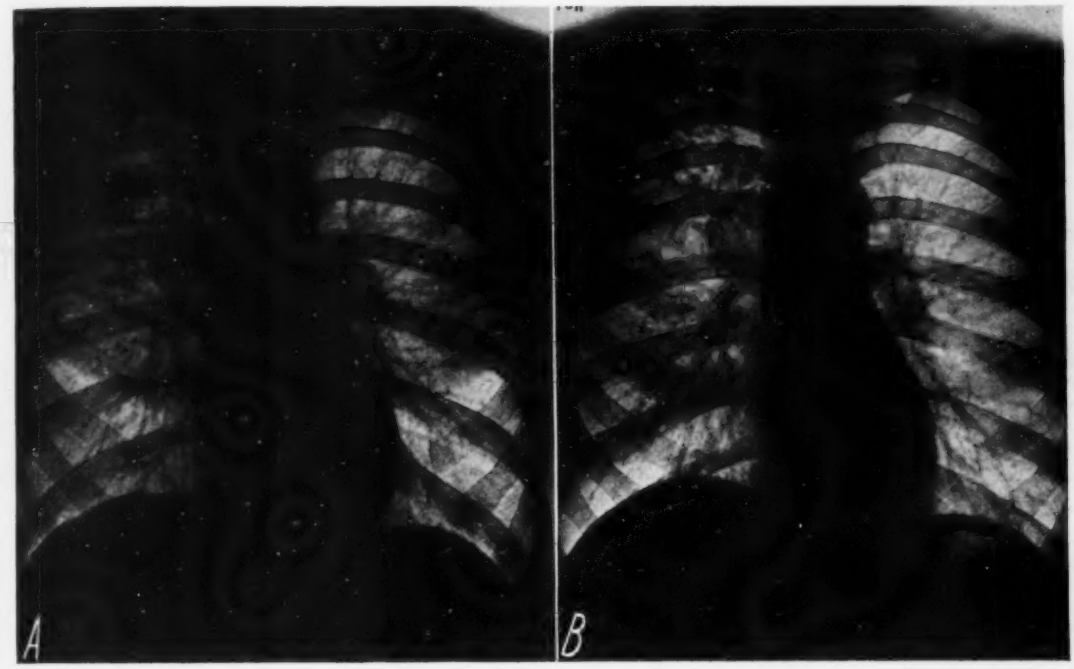

Fig. 2. Case 11. Arthur W. *A*, February 24, 1938. Fine and coarse nodular infiltration in right upper and mid-zone. *B*, September 30, 1942, considerable resolution. Some clear-cut fibrotic and calcified shadow. remain.

experienced their spontaneous healing, an expectant attitude seems worth trying in the cases described. The patient should stop work, have complete bed rest and should be under observation, preferably in a sanatorium for six to nine months, so that active therapy can be initiated in case of deterioration. But it is advisable not to be too hasty in commencing active therapy, as it may be a year or even more before improvement becomes noticeable. Even periods of deterioration may occur prior to the improvement. Although this is so, one cannot advocate an expectant attitude in cases of clinical and/or roentgenological observation in the sanatorium, advice for living outside, permission to work, and so forth, should be judged individually in each case. It is worth mentioning that some patients have been followed up who did not stop work, as they always felt fit enough to carry on, nevertheless their hematogenous spread healed.

The suggestion of expectant therapy is not to be taken as a fixed rule. There are patients who cannot afford to be off work for a long time, and their doctor although knowing the possibility of spontaneous healing may wish to curtail the illness by active therapy. Considerations like that

are quite understandable. Healing which may take place following such measures must be critically assessed and should not be attributed to them exclusively. It is well to bear in mind that artificial pneumothorax treatment usually takes longer, apart from the complications which may happen during this treatment.

Observations made on 2 patients suffering from bilateral hematogenous spread give rise to special consideration. In both patients an artificial pneumothorax had been induced in one lung. For reasons unknown to me an artificial pneumothorax was not induced on the other lung. Both, the lung treated with artificial pneumothorax and the other not so treated, healed approximately simultaneously. It is usual to attribute the healing of the second lung to a so-called contralateral artificial pneumothorax. Mentioning those 2 cases the existence of a contralateral artificial pneumothorax and its efficacy should not be denied. But having experienced the spontaneous healing of hematogenous spreads, some doubts are justifiable as to whether it is necessary in *these 2 cases* to regard the contralateral artificial pneumothorax as an explanation of the healing of the other lung.

II

In some cases the roentgenological manifestations of the hematogenous spread show a special feature. The clinical signs are the same as those described in the first part of this paper. Roentgenologically the spread consists of strikingly small closely set foci similar to millet seeds. The pattern of this type appears at first sight the same as that of miliary tuberculosis.

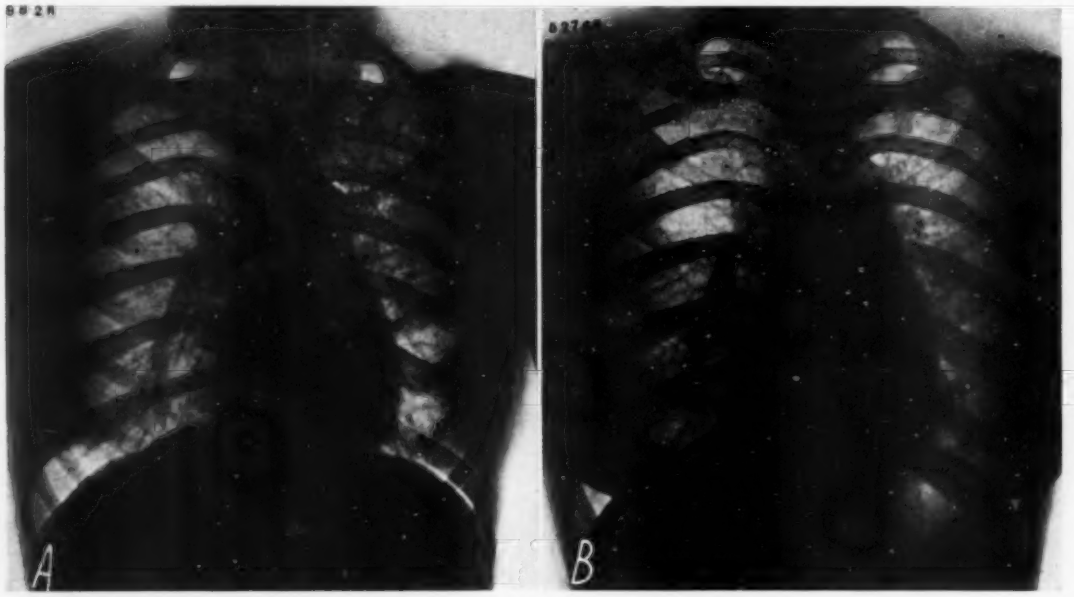

FIG. 3. Case III. Lilian D. *A*, March 12, 1942. Even distribution of small foci in left upper and mid-zone. *B*, October 25, 1943, resolution, residual fibrosis.

In typical (acute and chronic) miliary tuberculosis both lungs are rather uniformly affected, whereas in our cases only one or several circumscribed areas in one or both lungs are affected. The name "localized miliary tuberculosis" might suitably be given to distinguish the cases concerned. On the extent of the spread depends whether a total bilateral or a localized miliary tuberculosis develops. The tendency to spontaneous healing generally recognized to be a feature of total bilateral miliary tuberculosis is also characteristic of localized miliary tuberculosis. The manner of healing is the same as that described in the first part of this paper.

Some cases of localized miliary tuber-

culosis have been followed up, in which there was no proper healing, but an obvious benignity has been predominant in that both the clinical and the roentgenological findings remained unchanged.

Several spreads of localized miliary tuberculosis may occur in different areas of the lung in the same patient.

It may be that a miliary spread takes place, apart from the lung, in some other spread in the cases concerned. The roentgenological manifestations, especially those of the miliary type in addition to the absence of a source of bronchogenic spread (cavity) suggest hematogenous as against bronchogenic origin of the lesions. The objection raised by the opponents of the hematogenous theory, that there does exist a small cavity undiscernible on the film, is not valid. If it were justified, it

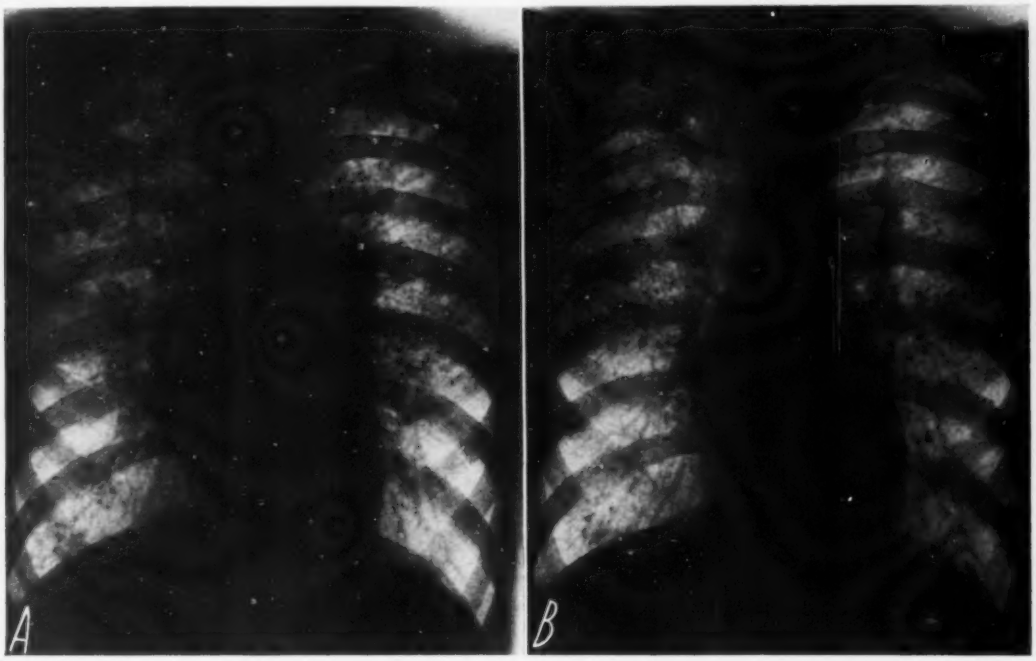

Fig. 4. Case iv. John C. *A*, May 11, 1936. Extensive bilateral mottling with confluence of foci in right and discrete nodular involvement in left. *B*, May 1, 1942. Numerous small calcified foci in both lungs.

organs either simultaneously with the spread in the lung or independent of it. A spread into the meninges has been observed. One of our patients died of meningeal spread two years after the localized miliary tuberculosis in the upper zone of the right lung had been diagnosed.

III

The main purpose of this paper is to draw attention to the spontaneous healing of a uniform extensive or localized tuberculous spread in the lung. The cases on which the observations are based lead up to a short discussion of the nature of the might be made during interpretation of any film, irrespective of whether it shows pathological manifestations or not. Furthermore, one could never assume the healing and disappearance of any tuberculous lesions, let alone of a cavity.

The spread is thought to have been established in the interstitial tissue, not having a communication with the air passage. In the clear cut cases described above râles, even post-tussic, are absent. Râles come about *within* the canalicular system, when fluid (or semisolid) material and air are mixed and moved during respiration. That is why special importance has been

attached to the absence of râles as a diagnostic criterion for the type concerned. On the other hand, even a hematogenous spread originally localized in the interstitium can, of course, growing proceed to the canalicular system and become in this way a bronchogenic tuberculosis, which then clinically presents râles. For the pathology and pathogenesis two papers by Rubin[9,10] should be consulted. Rubin distinguishes two main types of hematogenous spread: one due to spread via the bronchial arteries resulting in an interstitial spread, the other one by the pulmonary arterial route with tubercles developing in the terminal air sacs and bronchioles.

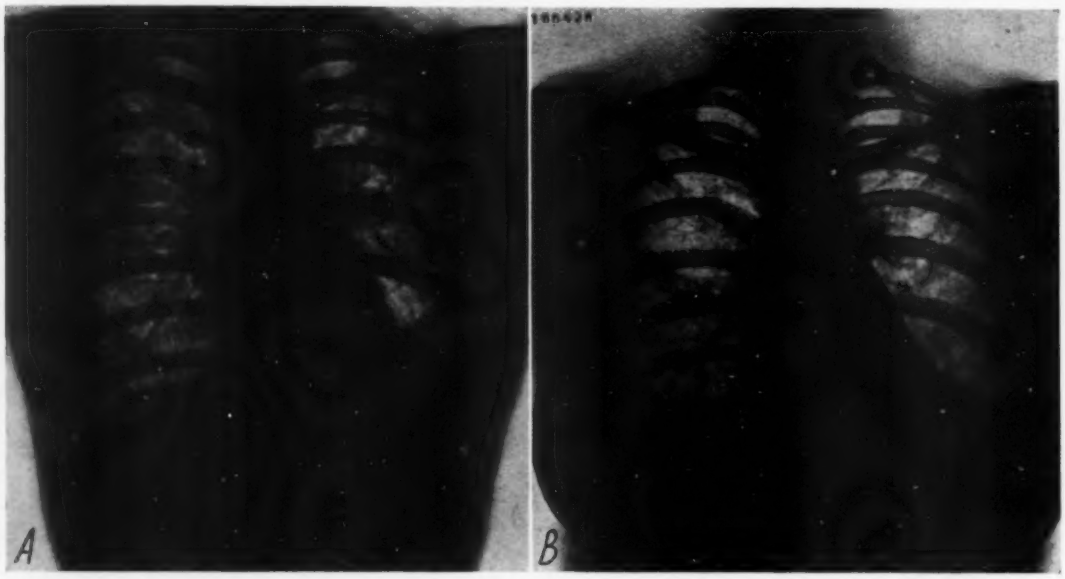

FIG. 5. Case v. Sarah N. *A*, July 19, 1941. Mottled infiltration with nodules of varying size in both lungs. *B*, July 28, 1944. Resolution. Bilateral fibrosis and slight calcification on the level of right second rib.

It has been alleged that hematogenous spread is bound to be bilateral and symmetrical and that unilateral occurrence excludes blood-borne dissemination. Several of the cases described in this paper support Pagel's[7] contention that typical manifestations of hemic (disseminated) tuberculosis may be unilateral.

The conception of hematogenous origin of localized pulmonary tuberculosis was put forward as far back as 1901 by Bard[1]. Later Neumann[6] followed him and coined the name of tuberculosis miliaris discreta. This group has been described in France as granulie froid by Burnand and Saye.[2] "Localized miliary tuberculosis" thus appears to be a clinical subgroup of the hematogenous spread described above and essentially identical with the tuberculosis miliaris discreta of which pathological evidence has been adduced by Pagel[7] (1936, 1939). Such discrete miliary spread may be the result of a progressive resolution and diminution in the number of foci in what was originally a uniform widespread infection of the lung. All gradations from universal chronic miliary tuberculosis of the lung down to restricted collection of small foci in one small area are possible. Experimental evidence has been given that such restriction of the spread can be due to acquired immunity (Pagel, 1936).

Spontaneous healing of hematogenous spread has been documented by Reisner (1934) and Miller (1934). There is a far reaching agreement between Miller's and my own observations. It seems to be doubtful, however, whether the cases of

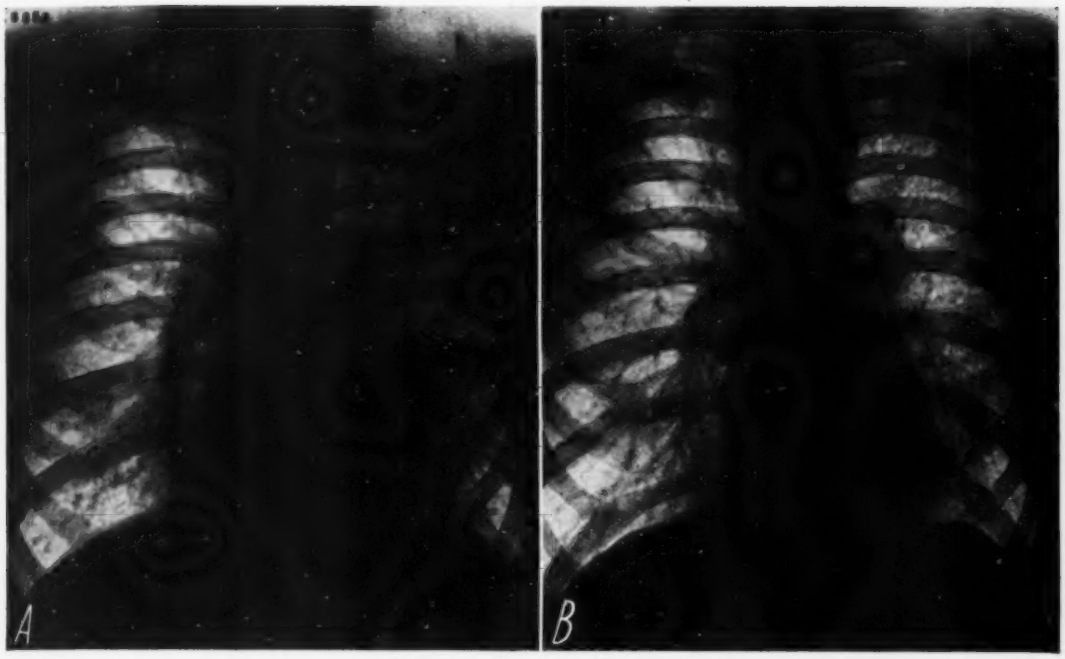

Fig. 6. Case vi. Norman S. To show that patchy infiltration may conceal an even spread of small foci. *A*, March 7, 1944. Patchy infiltration in left. *B*, October 18, 1944. After seven months' rest considerable resolution, evenly distributed small nodules remain.

Reisner and mine are of the same type. Dealing in his paper with the simultaneous occurrence of extrapulmonary tuberculosis he admits hematogenous dissemination in patients with extrapulmonary tuberculosis; in none of my cases, however, were extrapulmonary manifestations found. Reisner seems to attach some importance to bi-

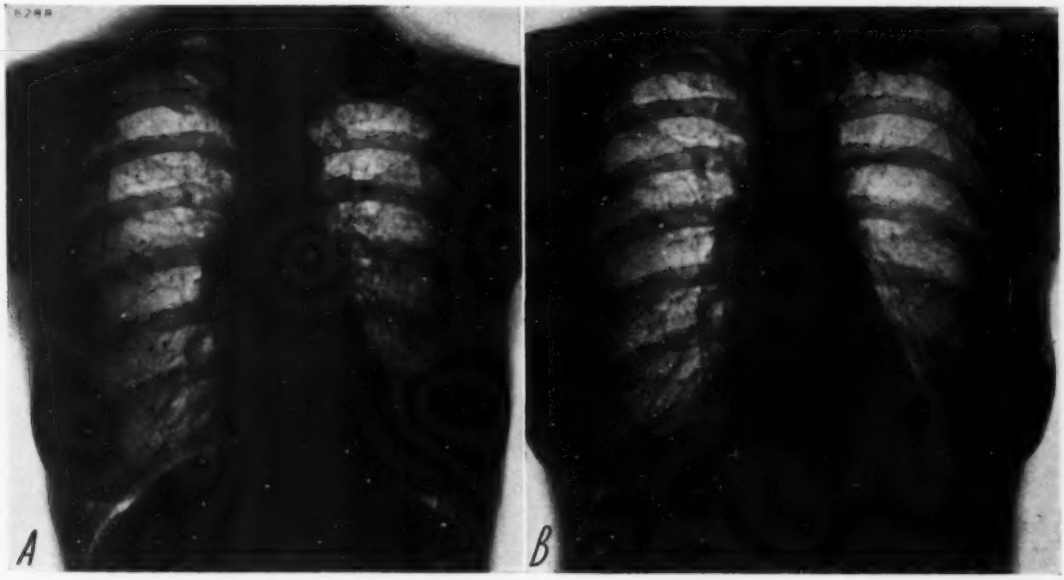

Fig. 7. Case vii. Lucy S. *A*, February 8, 1940. "Localized miliary" in mid- and lower zone. Large calcified mass in left apex. *B*, October 23, 1941. Resolution.

lateral spread with symmetrical involvement of both lungs to an equal extent, while I am in a position to have shown cases of unilateral spread, some of them affecting only a larger or smaller area of one side. Furthermore, the apicocaudal distribution, the foci gradually decreasing in number and in size from apex to base, with distinct predominance in the upper fields is supposed to be a striking feature in the cases of Reisner, but not in my cases. Unlike me Reisner stresses compensatory emphysema. Regarding spontaneous healing one may be inclined to question his assumption that foci, although no longer perceptible in the roentgenogram, may still anatomically exist, but escape detection due to their minute size (vide above).

SUMMARY

A type of pulmonary tuberculosis shows on the roentgenogram a characteristic *even* distribution of more or less closely set foci in larger or smaller areas (hematogenous spread), physical signs being absent. Cases of this type have some tendency to spontaneous healing by resolution, calcification and fibrosis.

A subdivision of this type is distinguishable on the roentgenogram by the pattern of "miliary tuberculosis," which is restricted to one or several circumscribed areas; the name "chronic localized miliary tuberculosis of the lungs" is proposed for those cases.

I wish to thank Dr. N. Gebbie, Medical Officer of Health, for permission to publish this paper. My sincerest thanks are due to Dr. R. Hermon and Dr. W. Pagel for their considerable help and criticism. Furthermore my thanks are extended to Dr. R. Hardy, T. O.

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THE ROENTGEN APPEARANCE OF PRIMARY RETICULUM CELL SARCOMA OF BONE*

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INTRODUCTION

IN 1939 Ewing[2] reviewed the classification of bone tumors for the Bone Sarcoma Registry of the American College of Surgeons and accepted reticulum cell sarcoma as a primary bone tumor. In his report he stated that Kaufmann had recognized the existence of a pure reticulum cell sarcoma of bone marrow many years ago and that Oberling and Raileanu had later furnished a substantial basis for the segregation of this type of tumor. Parker and Jackson[3] in 1939 presented the first group of cases of primary reticulum cell sarcoma of bone. Of their total of 17 cases they were able to select 13 from a review of Bone Registry material, and to these they added 4 from their own experience. Theirs was a clinical and pathological study in which they emphasized the difference between primary reticulum cell sarcoma of bone and the generalized form of reticulum cell lymphosarcoma. Parker and Jackson pointed out that most of their patients were under forty years of age; that there was a predilection for the long bones with involvement of a single bone; that the patient's general condition was good; and finally, that the course of the disease was relatively long. Their findings contrasted significantly with those of Craver and Copeland[1] who in 1934 reported 17 cases of the generalized form of reticulum cell sarcoma having bone involvement. These patients were in an older age group, had involvement of multiple bones, chiefly spine and pelvis, and ran a retrogressive course. The majority died within three years of the onset of the disease and within one year following the appearance of bone lesions.

Since the work of Parker and Jackson a number of case reports of primary reticulum cell sarcoma of bone have appeared in the literature.

We have had the opportunity of studying roentgenographically 17 cases of primary reticulum cell sarcoma of bone with adequate clinical, roentgenographic and pathologic data. Every case included in this group had at least one histopathological examination from bone. Dr. Fred W. Stewart confirmed the diagnosis on these patients. Selection of our material has been primarily on the basis of a dependable pathological diagnosis, together with satisfactory roentgenological studies and absence of generalized disease on admission.

The literature contains no study devoted to the roentgen diagnosis of primary reticulum cell sarcoma of bone. When the roentgenographic appearance has been touched upon, it was thought to be of little or no diagnostic aid. However, our experience indicates that there is a significant similarity in many cases of primary reticulum cell sarcoma. Furthermore, in certain instances we believe the appearance can be fairly characteristic. Recently we have been able to suggest the diagnosis to the clinician from the roentgenographic appearance alone.

Most bone tumors require histopathological proof for proper management whether the treatment be by surgery, irradiation or both. Nevertheless one must always consider the roentgenologic appearance as having a significant bearing on the final diagnosis. For an entirely acceptable diagnosis the clinical, the roentgenological and the pathological features must be consistent. It is particularly important when dealing with an unusual tumor that a close correlation of the three above mentioned elements exist.

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Bone tumors, whether benign or malignant, have a more or less characteristic roentgen appearance. This appearance must be critically studied and resolved into its basic components if one is to follow a systematic and productive approach to the roentgen diagnosis. This principle is to be applied in the following discussion of the roentgenographic diagnosis of primary reticulum cell sarcoma of bone. Specifically we are to follow here a more or less standard plan that we generally pursue in attempting to make a roentgen diagnosis in any bone tumor case.

ROENTGEN DIAGNOSIS

1. *Location in Skeletal System.* Of the 17 cases in this series 4 were located in the femur, 5 in the tibia, 2 in the humerus, 2 in the scapula, 2 in the vertebrae, and 1 each in the fibula and rib. In Parker and Jackson's cases 5 occurred in the femur, 3 in the tibia, 3 in the humerus, 4 in the clavicle and 1 each in the scapula and mandible. We have no cases in the skull or small bones of the hands or feet. In these 34 cases it is thus seen that four-fifths involved the tubular bones.

Seven tumors in our series arose about the knee, 3 being in the distal femur and 4 in the upper tibia. Seven of Parker and Jackson's cases were situated about the knee. It is interesting to note that in the combined group of 34 cases about 40 per cent were found in the region of the knee.

2. *Location in Bone.* This refers to the region in which the bulk of the tumor is situated, i.e., epiphyseal, diaphyseal or metaphyseal. It is most aptly applied to tumors occurring in tubular bones. Twelve of our cases were in tubular bones, 5 being located in the diaphysis. Three of these 5 were located in the mid-shaft while 2 were away from the center of the shaft. In the remaining 7 cases the bulk of the tumor was in the epiphyseal region but by no means always confined to it. In 2 cases in vertebrae the major site of involvement was the body. Of the scapular lesions in one the spine and in the other the spine and glenoid were the site of the tumors and in the rib case the tumor was in the posterior part of the rib.

The epiphyseal line remained open in only 3 cases (Cases 4, 7 and 36). In one of these the tumor stopped at the epiphyseal line. In another the tumor while situated towards the end of the shaft bore no relationship to the open epiphysis. In the last case it appeared that the epiphyseal line was crossed by the lesion.

Location in bone would appear from these findings to have no particular significance in reticulum cell sarcoma.

3. *Site of Origin.* In designating the site of origin an attempt is made to state whether a tumor arises from cortical or medullary bone or from the periosseous structures. In 16 cases there seemed to be little question but that the process arose from medullary or cancellous bone. In a single instance (Case 1) there was a possibility that the tumor might have had a cortical beginning.

4. *Symmetry in Bone.* The concept of symmetry in bone concerns particularly the tubular bones. Its determination must be based on a study of both sagittal and lateral views and both the osseous and periosseous components of the tumor are to be considered. In those tumors we designate as being symmetrical the vertical axis of the tumor coincides with the axis of the bone. Considering here only the tumors occurring in long bones, 8 were asymmetrical and 4 were symmetrical or nearly so.

5. *Direction of Growth.* It may be of some diagnostic importance to note the course that a bone tumor takes as it grows. Enlargement may be within the medullary portion of the bone or it may be outwards into the periosseous structures. In our cases the growth tendency seemed to be endosteal, over half being contained almost entirely within the bone. In all but 2 of the remaining tumors the direction of growth was predominantly endosteal.

6. *General Configuration.* Careful study of sagittal and lateral views of most bone tumors should enable one to determine the

outline or configuration of the process. In evaluating this characteristic the periosseous as well as the osseous part of the tumor is considered. From a practical standpoint only a gross estimate such as fusiform, ovoid or spherical seems important. Excluding of necessity the 2 cases in vertebrae and 1 in rib, 9 tumors presented an ovoid configuration and 5 tended to be fusiform. The fusiform cases were all located in the shaft.

7. *Destruction and Production in Medullary Bone.* Destruction was present to some degree in every case and it was the predominant change in medullary bone in 11 of the 17 cases. In 3 additional tumors production and destruction were about equal in degree.

Productive change, i.e., the formation of normal bone, the deposition of osteoid material, or the presence of calcification, was a less commonly noted finding in the medullary bone area. In only 3 instances, all of which occurred in the upper tibia, was production more prominent than destruction, although in 8 cases the former was present to a slight degree. In 6 tumors there was no productive change.

These findings would indicate that medullary bone destruction is a constant and usually predominant feature over production in primary reticulum cell sarcoma.

8. *Structure of the Tumor.* The structure or pattern of reticulum cell sarcoma is not characteristic although it may be a helpful point in diagnosis. The structure of the osseous portion of this tumor is often a patchy arrangement of areas of destruction often associated with similar sized areas of production. There is no pattern in the periosseous part of the tumor, it being observed almost without exception that there was no calcification in the soft tissue tumor apart from the periosteal reaction.

9. *Boundary of the Tumor.* The boundary includes the osseous and periosseous parts of the tumor. One of the most constant features of reticulum cell sarcoma is its ill defined margins, the boundary being so described in every instance. The difficulty of determining the precise extent of the tumor in bone was emphasized in several cases when after reparative changes had occurred following treatment the extent of the tumor was found to be greater than initially estimated.

10. *Condition of Cortex.* In all these cases cortical destruction was a constant finding. This varied from very fine irregular areas to wide sections of erosion, thinning and destruction. In no instance was there expansion of the cortex or marked cortical thickening. No well defined "cortical shadow" was encountered.

11. *Condition of Periosteum.* Periosteal change was not found to be a prominent feature of reticulum cell sarcoma. Excluding of necessity from consideration those tumors occurring in the vertebral bodies, 10 cases had varying amounts of periosteal reaction and 5 cases had none. In only 3 instances (Cases 2, 7 and 14) was the periosteal change moderately prominent. It was frequently necessary to search the roentgenogram carefully to detect any periosteal change. When there was periosteal reaction, it was of the lamellated type, being accompanied in several instances by a minute reactive periosteal triangle at one margin of the tumor. The perpendicular type of periosteal reaction was also noted in 2 cases, but in both of these the lamellated type of reaction predominated.

12. *Periosseous Changes.* Thirteen cases had roentgenographic evidence of a periosseous tumor component. Only twice did the size of the periosseous tumor exceed the area involved in bone. In 3 other instances the soft tissue mass was somewhat prominent. In the remainder the mass was small to minimal. The size of the mass appeared to have no relation to the duration of the disease.

13. *Joint Changes.* In those cases where the process was in the region of the knee, roentgenographic evidence of joint change was not uncommon. Of the 7 cases in this location synovitis was present in 5. In 1 patient (Case 1) the synovitis was the prominent feature on initial examination

elsewhere, leading to a presumptive diagnosis of tuberculosis. In no instance was the effusion a large one.

14. *Pathological Fracture.* There were 4 pathological fractures, 2 in vertebrae and 2 in the mid-shaft of an extremity. All these healed following radiation therapy. The vertebral bodies showed slight residual compression deformity and the humerus and femur presented some degree of malunion but gave functioning limbs.

15. *Multiplicity.* In none of these cases was there evidence that more than one bone was affected.

16. *Rate of Growth.* In several cases the tumor was examined periodically by roentgenograms for a few months during which the patient had no form of treatment. The most significant and complete observation series of this sort was in Case 15 where during five months periodic roentgen examinations were made. There was no difference in the characteristics of the tumor during this time. In the five months' interval the tumor increased its size 40 per cent. It seemed that this growth rate was about the same as in 2 other instances where interval studies could be made (Cases 1 and 13). These findings suggest to us that reticulum cell sarcoma is a rather actively growing tumor. The duration of symptoms of an average of six and one-half months based on all cases also suggests a fairly aggressive tumor.

17. *Response to Irradiation.* All these cases (except Case 17 which is now receiving treatment) responded well both clinically and roentgenographically when given adequate treatment by irradiation. Repair in the roentgenogram was noted as early as one month and on an average of three months following treatment. The first evidence of improvement was disappearance of the periosseous mass, soon followed by re-establishment of the cortex, subsidence of the periosteal change, and finally by the appearance of a general increase in density of the lesion to a degree slightly greater than that of normal bone. This increase in density was due to the formation of linear areas of bone resembling scar bone. The persistence of these changes has made it possible to identify readily the site of the treated tumor on roentgenograms taken six to ten years after therapy. In 2 instances where recurrence seemed apparent both clinically and roentgenographically the temporary reparative change was followed by bone destruction and the tumor tended to take on its original appearance (Cases 3 and 11).

Some estimation of the radiosensitivity and lethal tumor dose of roentgen radiation may be determined from a study of Cases 1 and 15. In the former, a seven and one-half year case with no evidence of disease, survival followed an estimated tumor dose of 2,200 r. In Case 15 multiple sections through the amputation specimen showed no viable tumor. This pathological examination was made several weeks following the completion of an estimated tumor dose of only 1,700 r. While the results in these 2 cases suggest a relatively radiosensitive tumor with a low cancericidal dose, most of these cases were estimated as having received a tissue dose in the range of 3,500 r.

Summary. Our findings indicate that primary reticulum cell sarcoma of bone is a radiosensitive tumor presenting constant features of single bone involvement, medullary origin, medullary and cortical bone destruction, ill defined borders and characteristic changes in the roentgenogram following roentgen therapy. The tumor tends to grow within the medullary portion of the bone with relatively small periosseous extension. Its osseous structure shows fairly regularly the presence of patchy areas of destruction often accompanied by areas of production with an absence of calcification in the periosseous portion of the tumor. Reticulum cell sarcoma tends to be ovoid in configuration when occurring at the ends of tubular bones and fusiform in the shaft and to be asymmetrical in position. Periosteal reaction is absent to moderate and when this feature is present it is of the lamellated type. There is a predilection for the long bones with over 40 per cent of the total

cases being located about the knee. In those tumors occurring about the knee, synovitis is not uncommon. In this group pathological fractures were present only in tumors of the mid-shaft of a long bone or in a vertebra. Reticulum cell sarcoma seems to be a moderately active tumor.

DIFFERENTIAL DIAGNOSIS

There was usually little difficulty in deciding that the roentgenographic diagnosis was tumor in these cases nor was there generally any problem in determining whether the process was a benign or malignant one. The essential problem was to state the type of malignant tumor. The tumor bearing the closest resemblance to reticulum cell sarcoma was osteogenic sarcoma. The separation of the more typical forms of sclerosing or osteolytic osteogenic sarcoma presented no great difficulty roentgenographically. It was in those osteogenic tumors of medullary origin in which the degree of production and destruction was nearly equal that the greatest problem arose. It was this type of tumor that most of these cases of reticulum cell sarcoma had been called. Osteogenic sarcoma in contrast to reticulum cell sarcoma is not a radiosensitive tumor and it shows no similar reparative change following therapy. Cortical destruction is thought to be less prominent and when present a cortical shadow is often noted. Osteogenic sarcoma shows less tendency to grow within the medullary portion of the bone or to show the fairly even patchy destruction and production in its osseous area, the internal pattern of osteogenic sarcoma being more disorganized, irregular and "wild." Periosteal reaction is a more prominent feature and the perpendicular type may be more frequently seen than the laminated type. There is a tendency for osteogenic sarcoma to form a larger periosseous mass and calcification of an irregular, amorphous type within this mass is more commonly seen. Synovitis is a less common feature in those osteogenic sarcomas occurring about the knee. Metastasis to the chest is the common sequela of osteogenic sarcoma.

When reticulum cell sarcoma occurs in the shaft, Ewing's tumor may have to be considered in the differential diagnosis. Ewing's tumor generally falls in a younger age group. Periosteal reaction is a more constant and prominent feature in Ewing's tumor. The osseous structure of the tumor is usually purely destructive. While both are radiosensitive tumors, they apparently differ fundamentally as to radiocurability. In addition the roentgenographic response to treatment is quite dissimilar. Ewing's tumor in our experience often responds with the reappearance of nearly normal looking bone in the roentgenogram while reticulum cell sarcoma presents areas of scar bone. Ewing's tumor more frequently metastasizes to the chest and presents the somewhat unusual feature of metastasizing to other parts of the osseous system. The course of Ewing's tumor is relatively short and generally terminates fatally. Reticulum cell sarcoma, in contrast to this, runs a relatively benign and long course with not infrequent five year survivals. We have found, however, that when Ewing's tumor occurs in an older age group, its roentgenographic appearance tends to be more atypical and its roentgen diagnosis less dependable.

Metastatic cancer in bone may cause considerable trouble in differential diagnosis if it is of the mixed productive and destructive type. In cancer metastasis to bone, cortical destruction is less constantly seen. The osseous structure in metastasis does not usually present patchy areas of production and destruction. Periosteal reaction, when present, is probably more often of the perpendicular type. When a periosseous mass is seen, it more commonly has calcification within it. We have not noted synovitis in association with cancer metastasis to bones about the knee. The existence of a primary source is strong presumptive evidence that the process is a metastatic one and in cancer metastatic to bone there is a tendency to multiple bone

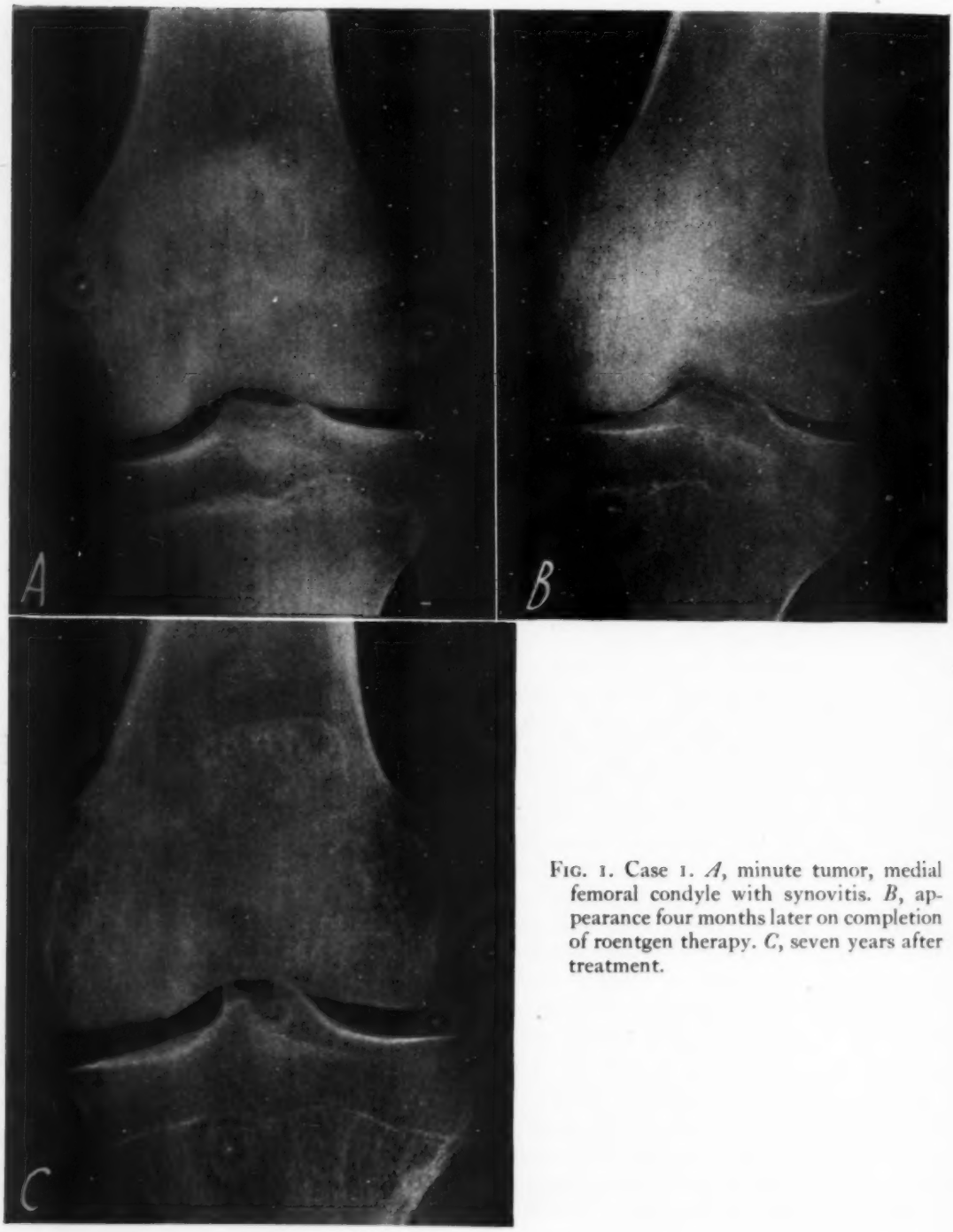

FIG. 1. Case 1. *A*, minute tumor, medial femoral condyle with synovitis. *B*, appearance four months later on completion of roentgen therapy. *C*, seven years after treatment.

involvement. Finally, response to irradiation is less favorable and such response as may be encountered lacks the more or less characteristic features noted in reticulum cell sarcoma.

In specific cases osteomyelitis, tuberculosis or rarer infections might be considered in the differential diagnosis of reticulum cell sarcoma. The bone changes of neuroblastoma and of the various forms of lymphoblastoma are to be differentiated from primary reticulum cell sarcoma of bone

chiefly on the multiplicity of bone involvement, the evidence of generalized disease, of changes in the blood and the clinical course.

It is well to remember that in the differential diagnosis of bone tumors their occurrence in bones other than the tubular ones tends to make diagnosis more difficult.

NOTES ON CLINICAL COURSE AND TREATMENT

It is not the purpose of this study to analyze the clinical aspects of reticulum cell sarcoma in detail but it seems essential for our purposes to mention some of the significant features in these cases. The age range was from thirteen to seventy-six years. We were unable to demonstrate any significant preponderance as to age group. In about half of the cases blood chemistry studies were made and showed values within normal limits. The clinical behavior of these patients appears to bear out the statement of Parker and Jackson to the effect that primary reticulum cell sarcoma runs a relatively benign course. Five patients are alive with no evidence of disease five years or more after treatment. Five patients are alive with no apparent evidence of disease three years or more after treatment. There were 3 deaths in the series. One current case probably has active disease. In the remaining 3 current cases (Cases 14, 15 and 17) 1 is showing favorable response to irradiation, 1 is well with no evidence of disease following preoperative irradiation and amputation, and 1 is in course of treatment. While Parker and Jackson considered amputation the treatment of choice, this procedure was carried out on only 1 of these cases. Otherwise irradiation was the treatment in all the rest except for 1 case in which irradiation was preceded by local excision (Case 7).

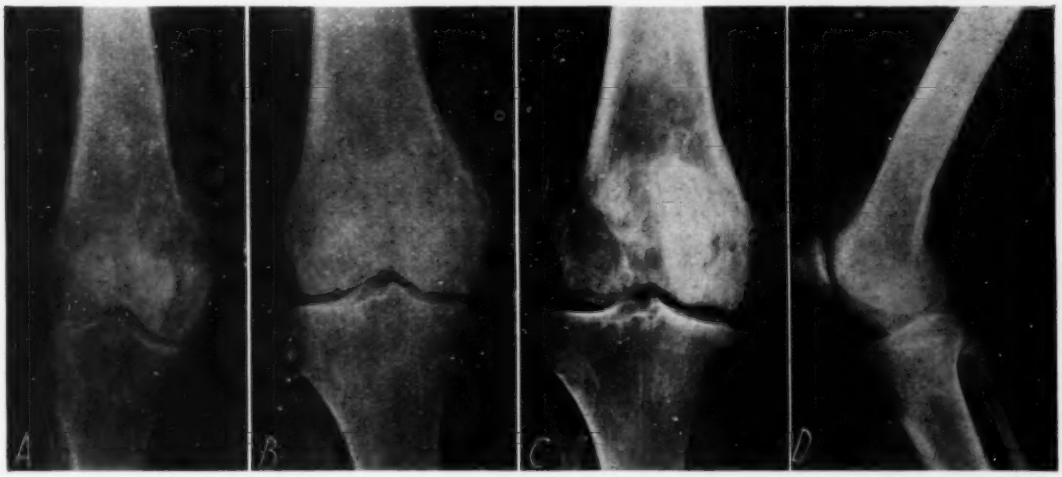

Fig. 2. Case 2. *A*, initial roentgenogram showing tumor involving entire medial femoral condyle. *B*, response one year after treatment. *C*, four and one-half years after treatment. This is the usual appearance after radiation therapy for reticulum cell sarcoma. *D*, lateral view showing synovitis accompanying tumor demonstrated in *A*.

CASE REPORTS

Case 1. For eight months prior to admission to Memorial Hospital this male, aged sixteen, complained of pain and swelling of the left knee accompanied by slight weight loss and fatigue. Pain was unrelieved by rest. Three months before admission, examination elsewhere showed swelling of the left knee with evidence of free fluid and tenderness medially. A roentgenogram at this time (Fig. 1*A*) revealed only a slight rarefaction at the medial femoral condyle and a considerable degree of synovitis. A provisional diagnosis of tuberculosis was made and at operation "thick and cloudy" joint fluid and "soft necrotic areas" in the medial femoral

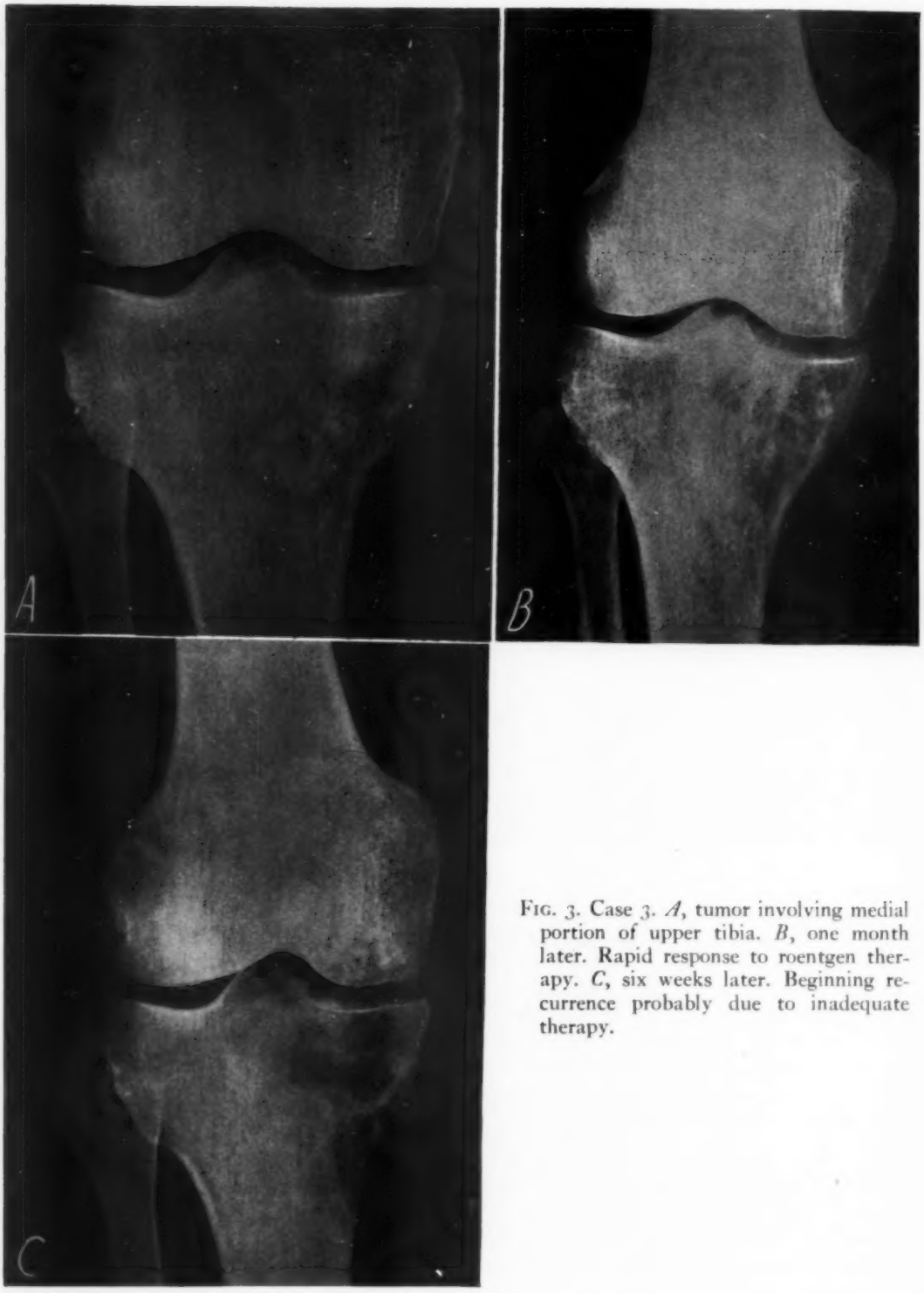

FIG. 3. Case 3. *A*, tumor involving medial portion of upper tibia. *B*, one month later. Rapid response to roentgen therapy. *C*, six weeks later. Beginning recurrence probably due to inadequate therapy.

condyle were described by the surgeon. Examination of the biopsy material showed no evidence of tumor but another biopsy was suggested by the pathologist. The patient was treated by immobilization of the limb for two and one-half months with no improvement.

Further roentgen studies showed increase in the size of the rarefaction at the medial condyle and beginning periosteal reaction. A repeat biopsy was therefore done which showed reticulum cell sarcoma. He was then referred to Memorial Hospital and roentgen therapy was given to the left knee for an estimated tumor dose of 2,200 r (Fig. 1*B*). The clinical and roentgenographic course was favorable. The patient has now been observed for seven and one-half years since treatment and is well with no evidence of disease (Fig. 1*C*).

Case 2. (Patient of Dr. Gray Twombly.) A female, aged twenty-five, complained of pain in the right knee following a fall. She was treated by plaster cylinder for thirteen weeks during which time there was continuous pain. Joint fluid was noted on removal of the plaster. Five months after onset of symptoms she was operated upon for removal of the internal semilunar cartilage. One month after operation a roentgenogram of the knee showed "osteoporosis of the lower end of the femur with elevation of the periosteum." Nine months after onset of symptoms she was referred to the Norwalk Tumor Clinic. Roentgenograms showed a tumor of the medial femoral condyle with accompanying synovitis (Fig. 2*A* and 2*D*). An aspiration biopsy showed reticulum cell sarcoma on smear and clot. Roentgen therapy was instituted, 3,000 r to a lateral and 2,700 r to a medial field (dose measured in air). There was complete relief of pain and she gained 23 pounds. Roentgenograms taken one year after treatment showed good healing (Fig. 2*B*). Except for occasional twinges of pain patient has remained symptom free and in excellent health three and one-half years after treatment. Recent roentgenograms show residual scarring such as is usually seen following treatment (Fig. 2*C*).

Case 3. (Patient of Dr. Julian B. Herrmann.) The patient, a male, aged fifty-five, received radiation therapy to a tumor of the right upper tibia (Fig. 3*A*), biopsy of which had shown reticulum cell sarcoma. Exact amount of radiation given is not known but there was good initial response to treatment (Fig. 3*B*). There was rapid recurrence as evidenced by increased bone destruction on roentgenograms taken six weeks later (Fig. 3*C*). One year after treatment patient developed upper respiratory symptoms which did not respond to chemotherapy. A roentgenogram showed fluid in the right chest.

Fig. 4. Case 4. Reticulum cell sarcoma of upper tibia.

An abdominal mass was also discovered. Laparotomy was performed at another hospital and retroperitoneal lymphosarcoma was found. Roentgen therapy was instituted and patient's condition was reported as fair to good two months after this treatment.

Case 4. For four months before being seen at Memorial Hospital, a male, aged seventeen, suffered with intermittent pain in the region of the right knee. Roentgenograms (Fig. 4) taken about two months before admission showed an extensive tumor of the proximal tibia. Several weeks before admission here the patient had two biopsies of the tibia. Submitted slides from the second biopsy have now been classified as reticulum cell sarcoma. On admission general physical condition was good. There was slight swelling over the upper tibia and the second biopsy wound was unhealed. Roentgen treatment was administered at another hospital in two series, one cycle before admission to Memorial Hospital and a second series six weeks later. Clinical and roentgen response was satisfactory and patient is alive and well over eleven years after the initial treatment.

Case 5. For two years before being seen at Memorial Hospital, a female, aged eighteen,

FIG. 5. Case 5. Tumor involving lateral femoral condyle.

complained of intermittent pain and swelling of the right knee. Roentgenograms taken about one year prior to admission were reported as showing changes in the lateral femoral condyle. Biopsy just prior to entry to this hospital revealed reticulum cell sarcoma. Physical examination failed to demonstrate a palpable tumor but roentgenograms (Fig. 5) were interpreted as probable osteogenic sarcoma. Soon after admission roentgen therapy was given for an estimated tumor dose of 3,700 r. The patient had a good clinical and roentgenographic response and when last examined five and one-half years after treatment, she was in good health with no evidence of disease.

CASE 6. A female, aged twenty-seven, was seen at Memorial Hospital complaining of intermittent pain in the left knee accompanied by a limp for five months. Physical examination showed swelling of the left knee, probably associated with fluid, and roentgenograms showed a tumor of the upper tibia (Fig. 6). The patient was two and one-half months pregnant. Two days after admission an aspiration biopsy of the tibia was reported as "fits with reticulum cell sarcoma." She received heavy irradiation through three fields to the left upper tibia over a period of one month. She had good initial response both clinically and roentgenographically. The patient was not followed at Memorial Hospital, but three years and two months after her roentgen treatment she was reported to be alive and well but showing late irradiation changes.

CASE 7. For two months before admission to Memorial Hospital, the patient, a female, aged thirteen, complained of swelling and pain in the right ankle. The pain was worse at night. Roentgenograms were interpreted elsewhere as osteomyelitis (Fig. 7). At operation a biopsy was taken which showed reticulum cell sarcoma. The patient was then referred to Memorial Hospital where a fibulectomy was done followed by roentgen treatment to the leg. The patient is now living and well with no evidence of disease three years since treatment.

CASE 8. For about six months before admission to Memorial Hospital, this male, aged fifty-three, complained of pain and swelling of the left arm. Roentgenograms showed a malignant process in the mid-shaft of the humerus (Fig. 8). Biopsy from the humerus was reported as primary tumor of bone, possibly reticulum

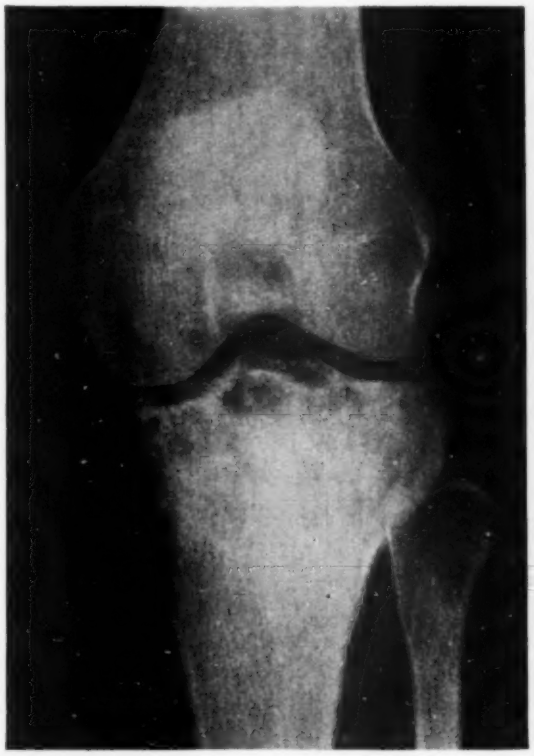

FIG. 6. Case 6. Extensive involvement of upper tibia.

cell sarcoma, and a second biopsy confirmed this diagnosis. He was then referred to Memorial Hospital. Physical examination revealed no peripheral nodes. There were findings in the chest of bilateral tuberculosis of advanced degree. Roentgen therapy was given to the humerus. Shortly after completion of this series patient sustained a pathological fracture. There was clinical improvement following therapy. A second series of roentgen treatments was given to the arm about a year and a half after the first. At this time the patient was readmitted to the hospital because of weight loss and a large abdominal mass which was thought to be liver. Treatment by radium element pack caused the mass to disappear. Twenty months after the first entry he was readmitted and was given 15 per cent skin erythema dose general body irradiation. During all this time the pulmonary tuberculosis progressed and a large cavity developed on the left side. He died at home of a massive pulmonary hemorrhage twenty-one months after first being seen.

Case 9. (Patient of Dr. Alfred F. Hocker.) A male, aged forty-four, fractured his left femur following a very slight trauma. The fracture had been preceded by a few weeks of pain in the left thigh. He was hospitalized and a cast applied but when the fracture failed to heal, he was transferred to a terminal home. Six months later (Fig. 9) he was admitted to another hospital where a biopsy of a large soft parts mass accompanying the bone tumor showed reticulum cell sarcoma. He was given roentgen therapy to four fields covering the entire femur for a total of 1,500 r (air dose) to each field.

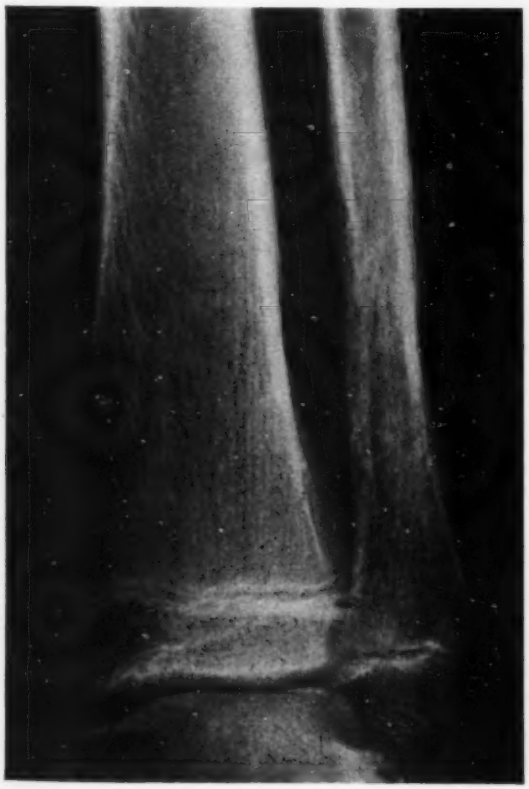

Fig. 7. Case 7. Lesion of distal third of fibula. There is a moderate sized soft parts tumor.

Fig. 8. Case 8. Mottled destruction of mid-shaft of humerus.

FIG. 9. Case 9. Tumor of mid-shaft of femur with pathological fracture. Metal splint in place.

There was solid healing of the fracture and he has remained alive and well seven years.

CASE 10. During the year before entry to Memorial Hospital the patient, a male, aged sixty-three, noted a swelling over the lower right chest posteriorly. There was pain related to this swelling for two weeks. On admission, physical examination disclosed a mass over the right eighth rib posteriorly. There were no palpable nodes. Roentgenograms (Fig. 10) revealed bone destruction in the eighth rib posteriorly and an associated intrathoracic mass which was well circumscribed. Aspiration biopsy was reported as malignant tumor. At operation the mass was not considered to be resectable. A biopsy was taken and reported as probably reticulum cell sarcoma of bone. Roentgen therapy was given with an estimated tumor dose of 3,500 r. Roentgenograms made following this treatment showed regeneration in the rib and disappearance of the tumor. The patient has remained well for three years with no evidence of disease.

CASE 11. A female, aged seventy-six, complained of pain in the left shoulder for one year before admission. A supraclavicular node excised one year previously had shown only hyperplastic changes. Nevertheless this had been treated by irradiation. Pain continued and

FIG. 10. Case 10. Tumor of right eighth rib posteriorly with extensive soft parts mass.

FIG. 11. Case 11. Lesion of spine and glenoid of scapula.

roentgenograms taken on admission (Fig. 11) showed a tumor of the scapula. There was an associated palpable mass. Biopsy of the scapula showed reticulum cell sarcoma. Following admission, treatment totalling 2,000 r (measured in air) was administered to the scapula. Several months before death there was evidence of fluid in the left chest and further bone destruction in the scapula suggesting recurrent disease. Twenty months after treatment the patient died at home.

Case 12. For three months before admission this female, aged thirty-six, complained of pain in the neck with weakness and stiffness in the left arm. Physical examination showed tenderness over the mid-cervical spine with marked spasm. There was no adenopathy. Roentgenograms revealed pathological compression fracture of the fifth cervical body (Fig. 12). Aspiration biopsy under roentgenoscopic guidance was reported as showing radiosensitive malignant tumor, most likely reticulum cell sarcoma. Roentgen treatment was begun and patient received 2,000 r (measured in air) to two fields over a period of three weeks. There was good initial clinical and roentgenographic response. Two months after treatment she was feeling fine but she died suddenly at another hospital three months later. We have been unable to ascertain the cause of death.

Fig. 12. Case 12. Involvement of fifth cervical vertebra.

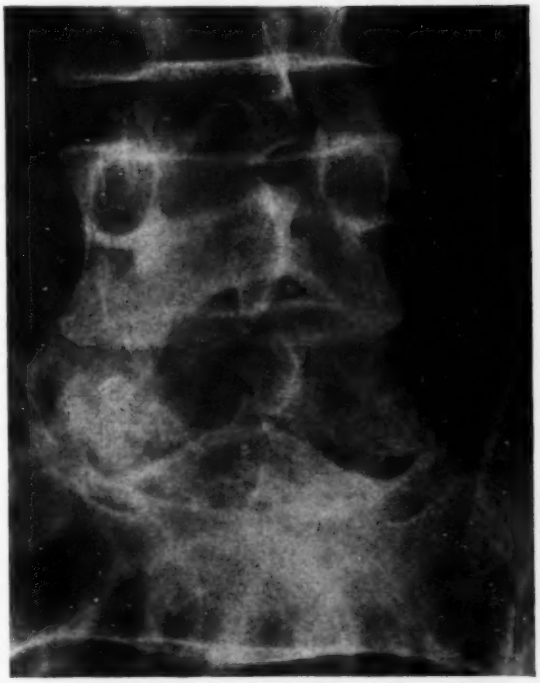

Fig. 13. Case 13. Tumor of the fifth lumbar involving the body, pedicles, laminae, and transverse processes. There was complete repair of these structures following treatment with residual sclerosis and slight compression.

Case 13. Following a fall ten months before entry to Memorial Hospital, a male, aged forty-eight, developed pain in the low back. Pain recurred after another fall seven and one-half months later. Roentgenograms made at this time (Fig. 13) were interpreted as fracture and the patient was put in a cast for six weeks. At the end of this time a biopsy was obtained surgically. This was reported as reticulum cell sarcoma and he was transferred to Memorial Hospital. Physical examination showed swelling over the last lumbar vertebra. There was no lymphadenopathy. Roentgen treatment was instituted. The patient improved and reparative changes were seen in the roentgenograms. He was well three years after treatment with no evidence of disease.

Case 14. For two years before admission to Memorial Hospital this female, aged twenty-one, had noted a vague ache in her right arm. This had become more severe in the past six months and she finally consulted a physician.

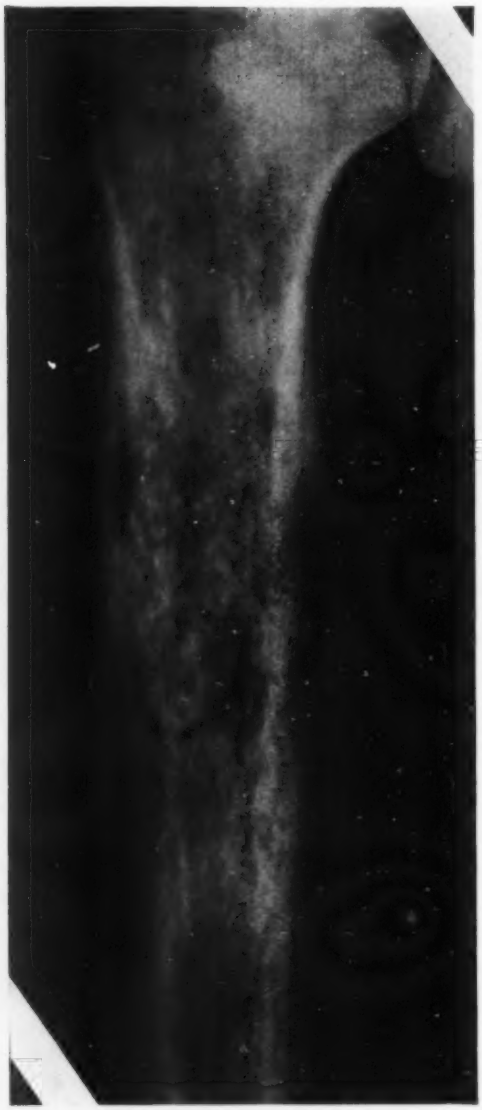

FIG. 14. Case 14. Tumor in proximal third of humeral shaft with moderate sized periosseous mass.

Examination had shown a mass in the right arm and roentgenograms (Fig. 14) showed a fairly extensive area of production and destruction in the upper third of the humerus accompanied by moderate periosteal reaction. The submitted films were interpreted initially by us as chronic osteomyelitis as being most compatible with the relatively long history of two years. Repeat films at Memorial Hospital taken six weeks after the first examination showed rapid increase in the size of the process with change in appearance to a more destructive character and with increased periosteal reaction of lamellated and perpendicular type. Two aspiration biopsies were not diagnostic, though the second showed malignant tumor insufficient to classify. An open biopsy was then performed and reported as reticulum cell sarcoma. Patient was four months pregnant on admission. Irradiation and Coley's toxins were chosen as the method of treatment. Twenty-four hours following the first injection of the toxins the patient spontaneously aborted a macerated fetus. Upon

FIG. 15. Case 15. Tumor in mid-tibial shaft.

recovery of the patient, the toxins were continued concurrently with roentgen therapy, the tumor receiving a dose of 3,200 r. A roentgenogram of the humerus taken one month following completion of therapy showed good initial healing and clinically the patient is symptom free. There has, however, been only two months follow-up.

Case 15. A male, aged fifty-four, complained of pain and swelling of the right tibia for eight months. Three months later a roentgenogram of the tibia had shown an irregular area of destruction and production in the mid-shaft. This progressed and about one month prior to admission to Memorial Hospital a biopsy was taken elsewhere under a provisional diagnosis of abscess. Pyelograms revealed a non-functioning right kidney and the question arose as to whether a primary malignant bone tumor or cancer metastasis from a kidney tumor was the diagnosis. Roentgen therapy was administered to the tibia, a total of 1,700 r into the tumor being completed ten days before admission to Memorial Hospital. A roentgenogram (Fig. 15) at time of roentgen therapy showed a mottled area of production and destruction in the tibial shaft. Physical examination on admission revealed diffuse enlargement of the anterior midshaft of the right tibia but no discrete tumor mass. Biopsy scar was well healed. There was slight tenderness to deep pressure but patient complained of no pain at this time. The opinion of the roentgenologist was primary reticulum cell sarcoma of bone. Dr. Fred Stewart reviewed the submitted biopsy section and felt the tumor was primary reticulum cell sarcoma rather than cancer metastasis as had been diagnosed elsewhere. A low thigh amputation was done. No residual viable tumor was found on multiple sections through the tibia. Patient is well with no evidence of disease five months since operation.

Case 16. A male, aged fourteen, had noted persistent pain in the left shoulder for eight months which did not respond to physiotherapy Roentgenograms taken at another hospital showed a tumor of the left scapula which was interpreted as osteogenic sarcoma and he was referred to Memorial Hospital. On admission he was in good general condition. There was a firm tumor mass about 6 by 9 cm. in the region of the spine of the left scapula and there was limitation of motion of the upper extremity. Roentgenograms showed a purely destructive tumor of the spine of the left scapula involving a small portion of the acromial epiphysis and accompanied by a large soft tissue mass. There was no periosteal reaction. Aspiration biopsy was reported as "Sarcoma: cellular, medium spindle and polyhedral cell." This slide has recently been reviewed by Dr. Fred Stewart and reclassified as reticulum cell sarcoma. Patient received roentgen therapy in two cycles over a period of four and one-half months for tumor doses of 3,540 r and 1,730 r. There was good clinical response to treatment and roentgenograms showed complete reformation of the scapular outline with only slight residual increase of density in the diseased area. Patient is alive and in good health ten years after treatment.

Case 17. A male, aged thirty-seven, began to complain of pain and swelling of the right knee one year before admission to Memorial Hospital. He was seen at several different hospitals, at one of which a diagnosis of Paget's disease was made. No treatment was accepted by the patient and he was finally referred to Memorial Hospital. Heat and elevation of the leg had given some relief from pain and he had been able to continue his work as a printer during the year. On examination the right knee was swollen and tender to pressure. There was slight edema of the upper third of the leg. There was a small effusion and slight limitation of extension at the knee. Roentgenograms showed a predominantly productive tumor in the upper third of the right tibia associated with slight periosteal reaction and small periosseous soft parts mass. There was slight synovitis. Aspiration biopsy was inconclusive, hence an open biopsy was done and reported as reticulum cell sarcoma. Patient is now receiving radiation therapy.

SUMMARY AND CONCLUSIONS

1. The roentgenographic features of 17 proved cases of primary reticulum cell sarcoma of bone have been presented according to a method applicable to all bone tumors.

2. Certain general principles in the roentgen diagnosis of bone tumors have been briefly discussed.

3. Differential diagnosis has been briefly

mentioned from the roentgenographic standpoint.

4. Irradiation was the sole method of treatment in these cases except one where it was used in conjunction with local excision and in another where it preceded amputation.

5. Roentgenographically and clinically primary reticulum cell sarcoma of bone seems to be a radiosensitive tumor of relatively good prognosis with some evidence that it may be a radiocurable tumor.

6. The roentgenographic appearance of reticulum cell sarcoma has been found to be suggestive of the diagnosis and in certain instances to be almost characteristic.

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POSTERIOR DISPLACEMENT OF LUMBAR VERTEBRAE

CLASSIFICATION AND CRITERIA FOR DIAGNOSIS OF TRUE RETRODISPLACEMENT OF LUMBAR VERTEBRAE*

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INTRODUCTION

POSTERIOR displacement of a lumbar vertebra, sometimes referred to as "reverse spondylolisthesis" or "spondylolisthesis posterior," consists of backward displacement of the cephalad vertebra in relation to the adjacent caudad vertebra. Our interest in this subject was first aroused by the comparative frequency with which this condition is encountered roentgenologically. Our curiosity was stimulated by Willis'[28] contention that the roentgen appearance of backward displacement of the fifth lumbar vertebra is due to an optical illusion based on a discrepancy between the mid-sagittal diameters of the adjacent articular surfaces of the fifth lumbar and first sacral segments.

After further investigation it soon became apparent to us that, while in some cases we were indeed dealing with an illusion such as described by Willis,[28] there were other cases which we thought represented true instances of subluxation and were based on the existence of pathological conditions and were not due to faulty technique or anatomical variations. When our study of this problem was begun we did not possess sufficient criteria with which we could accurately determine whether our suspected cases and those cases reported in the literature were actually true instances of retrodisplacement. The purposes of this study were (1) to ascertain whether or not the condition of posterior displacement of the fifth lumbar vertebra on the sacrum actually exists and, if it does, what anatomical factors are important for consideration; (2) to determine what factors, anatomical, pathological, and/or technical, influence the roentgen appearance of the lumbar vertebrae and sacrum; (3) to determine the roentgen criteria of true posterior displacement of lumbar vertebrae.

REVIEW OF LITERATURE

Although we found the condition of backward displacement of lumbar vertebrae to be more frequent than heretofore supposed, the paucity of reports on this subject is indeed striking. What little has found its way into the medical literature is often confusing and contradictory, and one is at once impressed with the feeling that the subject warrants a great deal of further study and clarification. While Friedl[7] and Junghanns[12] feel that posterior displacement of the fifth lumbar vertebra is a rare condition, the reports of Knuttson[15] and Johnson[11] lend weight to our contention that the condition is not uncommon.

The earliest reports concerning dislocations of lumbar vertebrae include an article by Brailsford[1] in 1929 in which he lists the causes of vertebral dislocations under four headings: (1) congenital malformations; (2) chondro-osteodystrophy; (3) trauma; (4) disease processes. Brailsford describes a case of tuberculosis of the spine in which there was backward subluxation of the fourth lumbar vertebra on the fifth lumbar vertebra. Hibbs and Swift[10] in the same year recognized the existence of the condition of backward displacement of the fifth lumbar vertebra on the sacrum and claimed that this condition is more likely to occur in vertebra whose articular facets are of the anteroposterior type, the facets facing laterally and medially. Such articulations, they believe, permit greater mobility be-

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tween the fifth lumbar vertebra and the sacrum.

Junghanns[12] in 1931 classified cases of vertebral displacement into three groups: (1) true spondylolisthesis; (2) pseudospondylolisthesis; (3) posterior displacement. He reports 7 cases of backward displacement of lumbar vertebrae, 6 of which involve the second lumbar, and in 1 case, involves the first lumbar vertebra. Junghanns[12] visualizes two possible mechanisms in the production of posterior subluxation: (1) either by trauma or by degeneration the disc narrows, resulting in approximation of the adjacent vertebral bodies with backward displacement of the cephalad vertebra. The inferior articular facets of the vertebra above glide backward and downward on the superior articular facets of the caudad vertebra. (2) Traumatic tearing of the capsules of the apophyseal joints, resulting in unstable and hypermobile joints, can eventually give rise to degeneration of the disc. This, in turn, may lead to abnormal movements in the intervertebral disc regions and retrodisplacement. In one of his cases, Junghanns emphasizes trauma as a probable cause of posterior displacement based on the discovery of central herniations of the vertebrae.

Schmorl[20] in 1932 reported 9 cases of posterior slipping, 8 of which occurred at the second lumbar level and 1 at the first lumbar level. He stresses and calls attention to, as one of the roentgen signs of posterior displacement, overlapping (in the anteroposterior axis) of the superior and inferior articular processes. In these cases he also describes such findings as narrowing of the intervening disc and subarticular sclerosis, the latter resulting from constant irritation of movement. He contends that the primary cause of backward displacement is narrowing of a disc produced either by trauma or degeneration. In some cases he finds herniation of the disc into the spongiosa of the vertebrae, and thus he believes that trauma may have played a role in some of these cases. He stresses the fact that as a consequence of narrowing of the disc, hypermobility of the adjacent vertebrae occurs and eventually causes laxity of the apophyseal joints. His cases occurred in the upper lumbar area where normally the articular facet surfaces are supposed to incline downward and backward. There is considerable doubt as to whether infection can be a factor in the production of posterior displacement of vertebrae, but Schmorl imagines that such a possibility exists, as for example, in infectious spondylitis due to typhoid fever.

Schmorl[20] mentions the observations of Güntz,[9] who noted that straightening of the spine occurs above the level of a vertebral displacement, and that similar straightening occurs in cases where there is disappearance of a single disc. Schmorl also refers to a case report by Mosenthal in which the first lumbar vertebra was displaced posteriorly. Waindruch and Korezky[26] have described what is probably the only congenital case of posterior dislocation in the literature; the fifth lumbar vertebra slid from the level of the sacrum to lie adjacent to the posterior surface of the upper third of the sacrum.

The importance of narrowing of the intervertebral disc as a cause of backward displacement of vertebrae is stressed by Williams and Yglesias.[27] In 1934 Ferguson,[5] in his discussion of lumbosacral anomalies, mentions and recognizes the condition of backward displacement of the fifth lumbar vertebra on the sacrum. Ferguson[4] believes this condition is commonly associated with symptoms and attributes the displacement in this region to hypermobile lumbosacral articulations. In the same year Johnson[11] reported that backward displacement is a common back condition and that it represents about 10 per cent of all cases where lumbosacral pathology is suspected. He attributes the condition to disc and congenital malformations and reports a series of 12 cases, explaining the symptoms on the basis of narrowing of the intervertebral foramina. Other factors, such as the intervertebral space, lumbosacral angle, and congenital malformations,

he says, are inconstant. Johnson[11] was unsuccessful in an attempt to reproduce on roentgenograms evidence of backward displacement of vertebrae by employing mounted anatomical specimens and altering their position in relation to the central ray of the roentgen tube. Thus, he thinks that this condition is not due to faulty roentgen technique, but rather represents a definite clinical and pathological entity. Johnson, however, used a rigid anatomical specimen in which he failed to simulate conditions in vivo, where rotation and lateral flexion usually occur with the patient lying on his side. A. DeForest Smith,[23] in 1934, in a period of approximately six and one-half years at the Clinic of the New York Orthopedic Hospital and in his private practice, discovered only 56 cases of backward displacement. Smith dwells on the importance of the structure and form of the articular facets as a primary cause of posterior displacement of the fifth lumbar vertebra. He believes that trauma plays only a secondary role and then only if a certain anatomical set-up is present. He states that in most of his cases the articular facets in the lumbosacral region face anteriorly and posteriorly, and he expresses the view that such joints are less stable and permit easier displacement. Smith operated on a number of these cases and found greater mobility in the lumbosacral joints than is normal in this region.

Willis[28] was the first to draw attention to anatomical variations in the posterior border of the first sacral segment. As a result of his observations on sacra and fifth lumbar vertebrae of 50 skeletons obtained from the Hammond Museum, he claims that backward displacement of the fifth lumbar vertebra represents an optical illusion. He bases his contention on a discrepancy in the anteroposterior diameters of the adjacent surfaces of the fifth lumbar and first sacral segments. Measurements of these anatomical specimens revealed that only 17 out of 50 showed equal anteroposterior diameters, while in 33 the anteroposterior diameter of the superior sacral surface was less than that of the inferior surface of the fifth lumbar vertebra. In the latter group most of the posterior borders of the superior sacrum were straight or convex, while in a few instances there was concavity of the posterior borders. Willis believes that the sacra with smaller anteroposterior diameters are responsible for the illusion of posterior displacement of the fifth lumbar vertebra. If this be true, we feel one should encounter a greater number of such cases, since we made measurements on roentgenograms of 100 supposedly normal individuals and found that 80 per cent of these patients showed the anteroposterior diameter of the superior sacral surface to be less than the adjacent surface of the fifth lumbar vertebra. Willis contends further that posterior displacement of the fifth lumbar vertebra cannot occur because it would have to travel "uphill." While it is true that we find more cases in the upper lumbar region than in the lower lumbar area due to the fact that the line of stress in the former is naturally downward and backward, we nevertheless found some cases at the lumbosacral junction where the lumbosacral angle was diminished or reversed, no longer making it necessary for the fifth lumbar vertebra to travel "uphill."

de Veer[25] applies the term "spondylolisthesis posterior" to the condition of backward displacement. In his case there is unmistakable backward displacement of the fifth lumbar vertebra as the anterior sacral border was found to project 1 cm. forward. de Veer thinks this condition is due to degeneration of the disc as well as loosening of the ligamentary apparatus. He adds that frequent small traumata might be instrumental in producing the condition, and he agrees with Junghanns that the arrangement of the apophyseal joints is an important factor. de Veer mentions Müller's[19] report of 2 cases due to degeneration of the discs, loosening of the ligaments and marked lordosis of the spine. In 1 of the cases three lumbar vertebrae were displaced backward in "staircase" fashion,

a description which arouses skepticism, because in our work we observe that such "staircase" phenomena are the result of faulty roentgen technique and do not represent pathological entities. We noted that "staircasing" is due to rotation of the vertebrae.

Another report in 1935 by Friedl[7] emphasizes weakening of the intervertebral disc as an important factor in backward displacement. He attaches the same importance to the condition of backward displacement as to anterior displacement. He reiterates that retrodisplacement is more common in the upper lumbar region than in the lower lumbar region, but he states that if the posterior portion of the lumbosacral disc degenerates more than the anterior portion and if the sacrum happens to be more horizontal than normal, posterior displacement of the fifth lumbar vertebra can occur.

Though Kleinberg and Burman[13] wish to consider their cases as atypical spondylolisthesis, we prefer to consider them as that of posterior slipping. The cephalad vertebrae are displaced posteriorly and contain defects in their posterior portions. Their examples fulfill our criteria for posterior slipping due to trauma—probably the only cases on record in which the evidence is so convincing of traumatic origin. Retrodisplacement instead of anterior slipping occurred due to the line of gravity pointing downward and posteriorly in contrast with normal conditions at the lumbosacral joint (or below the level of the third lumbar vertebra where the force is directed downward and forward). Lyon[16] cites a case of posterior displacement in the upper lumbar region, and he stresses the prominent role played by the posterior longitudinal ligaments in such a condition. Lyon also recognizes the importance of narrowing the intervertebral foramina in the ventrodorsal direction. Breck[3] believes that backward displacement of the fifth lumbar vertebra is due to narrowing of the disc and posterior inclination of the articular facets.

Comprehensive work on the subjects of disc degeneration and retrodisplacement has been done by Knutsson.[14,15] Disc degeneration causes abnormal movements between vertebrae and is the prime underlying etiological factor of posterior displacement. The roentgen signs of disc degeneration are therefore worthy of particular consideration in the subject under discussion. He lists the signs of disc degeneration as follows: (1) parallel displacement of vertebrae (retrodisplacement included); (2) narrowing of intervertebral space; (3) reactive changes in vertebral bodies; (4) vacuum phenomenon (Magnusson[17]); (5) abnormal locations of vertebrae in relation to each other; (6) abnormal motion. He advocates functional tests for stability of the disc by supplementing roentgenograms in the recumbent position with upright ones taken with the spine in flexion and extension. Such studies have shown that backward displacement is more frequent than previously appreciated or suspected. Furthermore, Knutsson is able to detect cases of so-called "incipient disc degeneration" by demonstrating parallel displacement without any other anatomical evidence of disc degeneration. He states that retrodisplacement is a manifestation of instability.

According to Fick[6] and Strasser,[24] parallel displacement does not occur between vertebrae in a normal spine. If displacement between vertebrae occurs, it signifies disc degeneration. Severin[21] has similarly reported retrodisplacement of vertebrae in 50 per cent of cases of disc degeneration.

ANATOMY

Anatomical variations in the lumbar spine, particularly at the lumbosacral joint, are frequent in occurrence. Roentgenographically one may encounter real or apparent abnormalities in this region, and unless one is constantly on his guard, errors in interpretation may result.

Although the normal lumbar curve is lordotic, wide variations in the lumbar curvature are seen both clinically and roentgenologically. The center of gravity of the body may be represented by a line which passes through the center of the body of the third lumbar vertebra. In the upper lumbar region, therefore, the stress is

downward and backward, while in the lower lumbar region the stress is downward and forward. The lumbar region of the spine permits a great deal of motion in forward, backward and lateral bending of the trunk, motion of vertebrae occurring at the intervertebral discs and in the apophyseal joints. These movable segments of the spine are supported by numerous ligaments which tend to stabilize the spinal column. The intervertebral fibrocartilage, which forms a tough covering of the disc, joins the inferior and superior surfaces of adjacent vertebral bodies, while the strong longitudinal spinal ligaments lend support to the vertebral bodies anteriorly and posteriorly. The posterior arch of the spinal column is supported by the ligamentum flavum and the infra- and supraspinous ligaments, while the apophyseal joints are stabilized by their joint capsules and the intrinsic muscles of the spine. The articular facets of the lumbar vertebrae have concave-convex surfaces—the superior facets being concave, and the inferior facets convex. Generally the facets in the lumbar region face medially and laterally, but in the lumbosacral region the articular facets quite frequently face anteriorly and posteriorly. The planes of the articular facets in the upper lumbar region tilt backward and downward, most authors claim, while in our experience the planes are more or less vertical.

The bodies of the lumbar vertebrae increase in size from the first to the last lumbar, and the pedicles tend to become shorter and broader as they approach the sacrum. Usually the body of the fifth lumbar vertebra exhibits flaring or skirting at the posterior-inferior margin. This skirting tends to widen the anteroposterior diameter of the body of the vertebra in relation to the corresponding diameter of the superior surface of the first sacral segment, the effect being exaggerated when slight rotation of these vertebrae is present. Though the posterior margin of the bodies of the lumbar vertebrae is usually slightly concave, the posterior margin of the body of the first sacral vertebra is most frequently convex or straight. Occasionally, however, the posterior border of the first sacral vertebra is found to be concave.

The intervertebral discs in the lumbar region of the spine are larger and thicker than those in the dorsal or cervical regions and tend to increase in size as they approach the sacrum. The height of the intervertebral discs in the lumbar vertebrae is greater anteriorly than posteriorly. This is particularly true at the lumbosacral interspace.

CLASSIFICATION

Following preliminary study of the literature and our roentgenograms it soon became apparent that not all cases of backward displacement were alike or due to the same factors. When some of these patients were re-examined roentgenologically backward displacement persisted as a constant finding in certain instances while in others signs of backward displacement vanished. In our attempt to separate the various types of cases of backward displacement, we formulated the following classification:

I. True backward displacement of lumbar vertebrae.
   A. Due to degenerative processes.
   B. Due to disease.
   C. Due to trauma.
   D. Due to congenital anomalies
II. Apparent backward displacement of lumbar vertebrae.
   A. Due to technical factors.
   B. Due to anatomical variations.

I. *True Backward Displacement of Lumbar Vertebrae.*

A. *Due to degenerative processes.* We believe that the greatest majority of true cases of retrodisplacement of vertebrae are primarily the result of degeneration of the intervertebral disc. Degeneration of the disc results in instability (Knutsson[15]) and relaxation of the longitudinal ligaments (Lyon[16]), permitting greater movement between the vertebrae which gives rise to stretching of the capsules of the apophyseal joints and ultimately retrodisplacement. Instability, according to Knutsson,[15] is usually accompanied by sclerotic changes and lipping of the articular borders as late signs, but parallel displacement can represent an early sign of disc degeneration, even though no roentgen evidence of narrowing of the disc is present. Degeneration of the intervertebral disc probably occurs as part of systemic degenerative changes. The disc is one of the first structures to suffer such changes because of the constant stress and

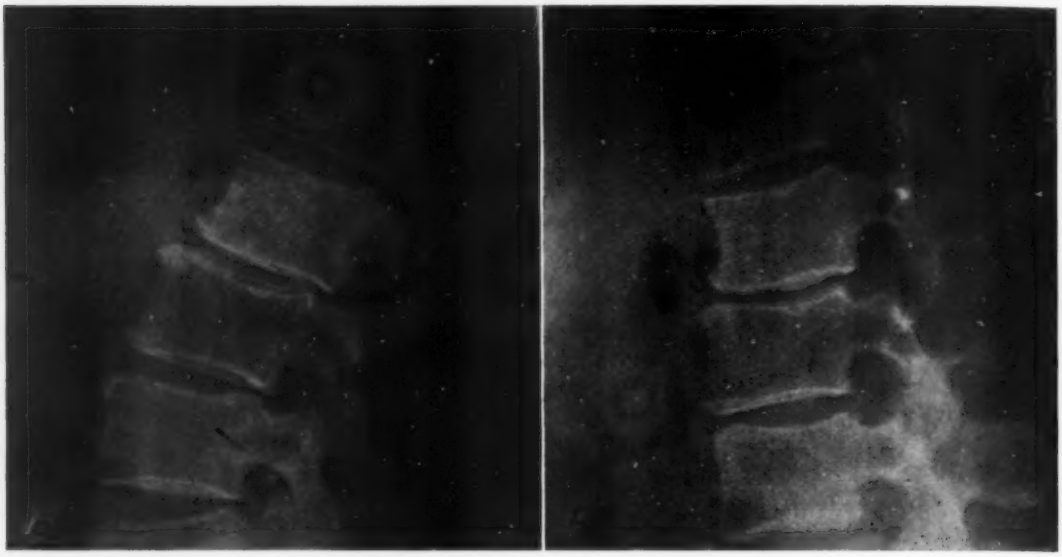

FIG. 1. *a*. Mr. C. H., aged sixty. Upright lateral roentgenogram in flexion shows posterior displacement of first lumbar vertebra on the second lumbar vertebra. Note marked narrowing of intervertebral space, vertical and anteroposterior narrowing of the intervertebral foramina resulting in "hour-glass" deformity of these structures, and overlapping of articular processes. *b*. In hyperextension there is increased retrodisplacement.

FIG. 2. *a*. Mr. R. H., aged forty-four. Lateral roentgenogram showing backward displacement of second lumbar vertebra on third lumbar vertebra with marked narrowing of the intervening space. Note reactive changes including subarticular sclerosis, lipping, spur formation, etc., and "hour-glass" appearance of the intervertebral foramina. Note characteristic "step-ladder" appearance of the other lumbar vertebrae due to rotation. *b*. Anteroposterior projection reveals rotary and lateral scoliosis of the lumbar spine which accounts for "step-ladder" effect noted in *a*.

strain and frequent traumata to which they are subjected. True cases of retrodisplacement occur more frequently in the upper lumbar region (Fig. 1, *a* and *b*, 2, *a* and *b*) than in the lower lumbar region (Fig. 3, 4, 5, 6, and 7, *a*, *b*, *c*) because the upper half of the lumbar spine—above the level of the third lumbar vertebra—inclines backward in relation to the center of gravity. In the lower lumbar spine, on the other hand, the stress is downward and forward, while the articular facets approach or lie in the vertical plane. Since the lumbosacral junction slants forward and downward, there is, of course, a greater tendency to anterior displacement in this region. Fewer true cases of backward displacement occur in this region in spite of the fact that the greatest incidence of disc involvement occurs here.

An important sign of retrodisplacement is what we have called the "hour-glass" appearance of the intervertebral foramina. The narrowing is, for the most part, in the ventrodorsal axis. The distance between the posteroinferior border of the cephalad vertebra and the anterior border of the superior articular process of the caudad vertebra is reduced by the displacement and produces an "hour-glass" appearance.

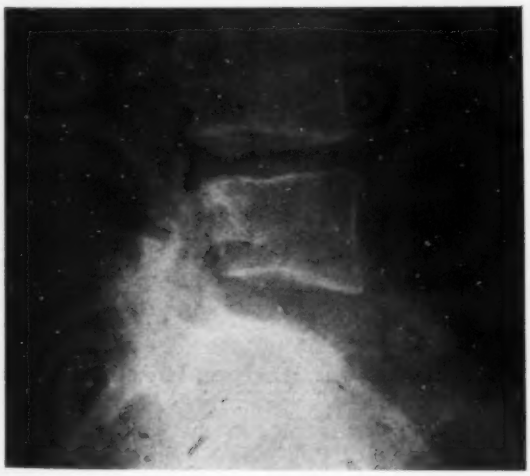

Fig. 3. Mrs. M. K., aged fifty-five. Lateral projection of lower lumbar vertebrae shows degeneration of anterior portion of fourth lumbar disc, with early reactive changes and slight retrodisplacement. The intervertebral foramina are narrowed.

Fig. 4. Mr. W. B., aged fifty. Lateral roentgenogram reveals posterior displacement of fourth lumbar vertebra on the fifth. Reactive changes are quite marked and the intervertebral foramina show typical "hour-glass" appearance. Widening of apophyseal joints (facets of anteroposterior type) well demonstrated (arrows).

If the intervertebral space is reduced in height then narrowing in the vertical axis also occurs. One must differentiate such "hour-glass" constriction found in true backward slipping from encroachment of these foramina by osteophyte or spur formation at the posteroinferior margin of the cephalad vertebral body.

In 2 of our patients with posterior displacement at the lumbosacral junction (Fig. 7, *a*, *b*, and *c*) the lumbosacral angle was actually reversed and the intervening discs showed thinning. Friedl[7] states that if the posterior portion of the fifth lumbar intervertebral disc degenerates more than the anterior portion and if the sacrum is more horizontal than usual, posterior displacement can occur as shown in our patients (Fig. 7 *a*, *b* and *c*). Degeneration of the articular cartilage of the apophyseal

FIG. 5. Mr. J. K., aged forty-five. Lateral roentgenogram of lumbosacral junction shows slight narrowing of the posterior portion of the intervertebral disc and slight retrodisplacement of the fifth lumbar demonstrated by widening of the apophyseal joint space (indicated by arrows).

joints could initiate the process of backward displacement only if, as a result of this degeneration, there occurred subsequently stretching of the ligaments, hypermobility of adjacent vertebrae, and ultimate degeneration of the intervening disc (Junghanns[12]).

B. *Due to trauma.* Sudden, severe trauma can produce backward displacement of vertebrae. Any severe trauma or injury to the disc, the osseous structures of the spine, the apophyseal articulations, or ligaments supporting the vertebrae can ultimately result either primarily or secondarily in backward displacement. In 2 of our patients the trauma was of sufficient severity to be considered as the probable etiological factor. Mr. H. E. fell and forcibly struck his back against the sharp edge of the stairs. He developed typical symptoms of a disc syndrome in the lumbosacral region and was disabled for several months. Roentgen examination (Fig. 7*a*) shows narrowing of the intervertebral space with retrodisplacement. The other patient, Mr. D. R., slipped while working in a boxcar and his back struck the sharp edge of the boxcar platform, following which he developed severe low back pains and sciatica. The roentgenograms (Fig. 7, *b* and *c*) reveal a narrowed interspace and retrodisplacement. At operation a ruptured disc was found at the lumbosacral junction.

Other examples of retrodisplacement of lumbar vertebrae probably due to trauma are the cases described by Kleinberg and Burman[13] who considered their cases as atypical spondylolisthesis. The upper vertebral column is displaced posteriorly on the inferior column and the retrodisplaced vertebrae show dissolution in their posterior portions.

C. *Due to disease.* Brailsford[1] describes a case of retrodisplacement which occurred

FIG. 6. Mr. R. W., aged forty. Lateral roentgenogram showing backward displacement of the fifth lumbar vertebra on the sacrum. Note narrowing of interspace posteriorly, narrowing of intervertebral foramina, widening of apophyseal joints (arrows). The apophyseal facets are of the anteroposterior type, the joint width being accurately demonstrated, therefore, in the lateral view. (Oblique roentgenograms failed to demonstrate the true width of these joints.)

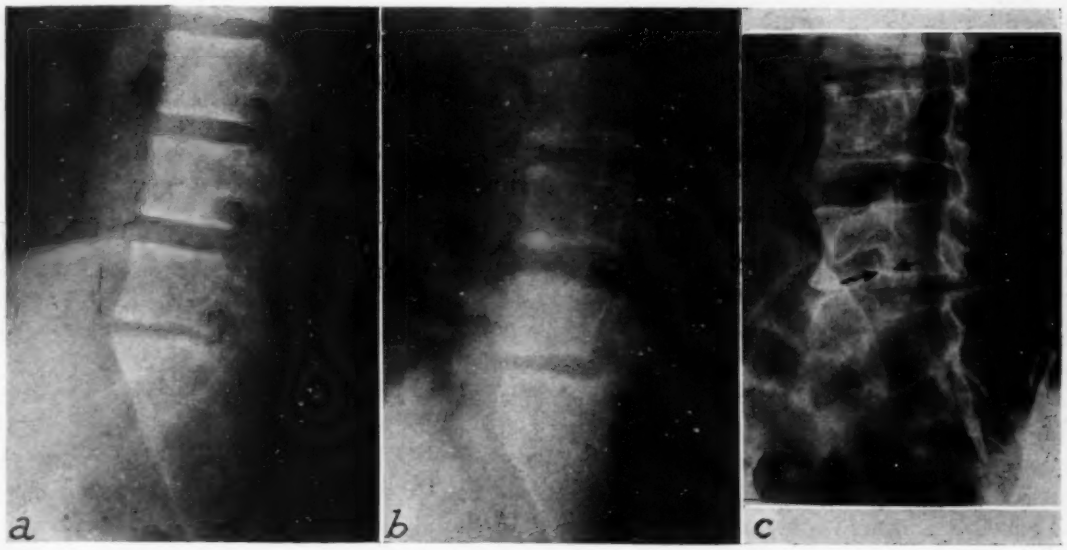

Fig. 7. *a*. Mr. H. E., aged thirty-seven, fell down some stairs and struck his back against edge of steps in May, 1945. Patient developed backache and sciatica on the left side and had been disabled for several months. Lateral roentgenogram demonstrates true backward displacement (overlapping of anterior and posterior margins of the vertebrae) with narrowing of intervertebral space at the lumbosacral junction. The intervertebral foramina are narrowed and subarticular sclerosis is visible. The lumbosacral angle is approximately −5 degrees. The lumbar curve is slightly kyphotic. (Film measurements: anteroposterior diameter of inferior surface of fifth lumbar is 46 mm.; anteroposterior diameter of superior surface of sacrum is 42 mm.)

b and *c*. Mr. D. R., aged thirty-four, fell off boxcar and injured his back on November 27, 1939. Patient developed disabling back pain with sciatic radiation. Lateral roentgenogram (September 30, 1941) shows posterior subluxation of the fifth lumbar on the sacrum. The lumbar curve is kyphotic, the fifth lumbar intervertebral disc is narrowed, and the lumbosacral angle is −5 degrees. Oblique projection shows definite widening of the apophyseal joint space (arrows). (Roentgen measurements: anteroposterior diameter of inferior surface of fifth lumbar is 49 mm.; anteroposterior diameter of superior surface of sacrum is 44 mm. Though a discrepancy between these anteroposterior diameters exists as in *a*, our criteria for true backward displacement are fulfilled.)

in tuberculosis of the spine. Other diseases of etiological significance which have been mentioned are syphilis, osteomyelitis, primary and secondary bone tumors, etc. Theoretically, conditions such as senile osteoporosis and osteomalacia might be of etiological importance.

D. *Due to congenital anomalies*. So far as we have been able to ascertain, there has only been one report of retrodisplacement of congenital origin. This case which was reported by Waindruch and Korezky[26] showed the fifth lumbar vertebra to be displaced posteriorly on the sacrum so that it slipped caudad and posteriorly to the level of the upper third of the sacrum. Though proof might be lacking, there is little reason to doubt that congenital relaxation of the ligamentous structures of the spine could be of etiological significance in some cases. One cannot deny that congenital factors might be responsible for early degenerative processes involving the disc structure. Abnormal architecture of the spine attributable to congenital anomalies is undoubtedly responsible in some instances of backward displacement. Articular facets facing anteriorly and posteriorly in the lumbosacral region probably do not form as stable a joint as those facing laterally and medially. Asymmetrical arrangement of the facets might likewise result in an unstable lumbosacral joint.

II. *Apparent Backward Displacement of Lumbar Vertebrae.*

Many cases originally designated by us as representing backward displacement,

upon critical review and reconsideration, were discovered either to represent errors in technique or to be due to anatomical variations, or both. Perhaps the commonest of all factors responsible for the appearance of backward displacement on roentgenograms is faulty technique. So common are the findings of backward displacement due to faulty technique, that it is our belief that numerous cases reported in the literature do not represent true instances of retrodisplacement. Many of the illustrations we have examined during our search of the literature are not too impressive and have not fulfilled our criteria for such a diagnosis.

Technical factors which can lead to errors in interpretation are faulty positioning of the patient on the roentgen table by disregarding the factors of rotation and sagging of the lumbar spine, incorrect alignment of the central ray to the structures in question, short target-to-film distance, etc. Anatomical and pathological factors which can account for apparent backward displacement are discrepancies between the mid-sagittal diameters of the fifth lumbar and first sacral segments, flaring or skirting of the posteroinferior border of the fifth or last lumbar vertebra, hypertrophic lipping of the posteroinferior margin of the cephalad vertebral body, tapering of the vertebral bodies, sacralization of the last lumbar vertebra and bevelled posterosuperior margin of the sacrum.

It is difficult to define exactly what constitutes a complete roentgen examination of the lumbosacral spine. As is true in gastrointestinal investigations, the roentgen findings in the lumbosacral spine will be directly proportional to the number of properly exposed films. The usual routine recumbent anteroposterior and lateral projections of the lumbosacral spine, in the light of recent advances in technique and interpretation, can no longer be construed to represent, even in the slightest, an adequate roentgen study. Examination in the upright position is strongly recommended.

In roentgen studies of the lumbosacral spine Knutsson has recently advocated and demonstrated the value of examining patients in forward and backward bending in testing for instability of the intervertebral disc and in the demonstration of hypermobility. Oblique projections are indispensable for visualization of the posterior portions of the vertebrae and the apophyseal joints. The value of the oblique projections is limited, however, so far as the apophyseal joints are concerned. The true width of the joints is of primary importance in the condition of retrodisplacement and this joint space is not accurately represented in oblique projections in most instances because of the variability of the planes of the articular facets. Should backward subluxation occur in patients in whom the facets face laterally and medially, widening of the apophyseal joint space would not be revealed by the oblique projections. As a matter of fact, there is actually no increase in the width of the joint space in such instances. The only demonstrable roentgen sign in such cases is overlapping of the articular processes (Fig. 1*a*). This can only be visualized on the lateral projections. But if the articular planes of the facets face anteriorly and posteriorly, the lateral projection should, if no other overlapping structures obscure, reveal true widening of these joint spaces (Fig. 4, 5 and 6). As a matter of fact, before a diagnosis of retrodisplacement of a vertebra with such facets can be made, widening of the apophyseal joint space must be demonstrated. Only in one instance will the oblique projections serve to depict widening of the apophyseal joint space in cases of posterior slipping. Such is the case when the planes of the articular facets lie obliquely (Fig. 7*c*). In the lumbosacral region, if the last lumbar segment is deeply set and/or if the iliac alae are large, overlying structures cause obscuration and such widening of the joints is difficult to demonstrate. In such cases, although we have had insufficient experience with this method, we advocate the use of sectional roentgenography or planigraphy. Theoretically at least, this method offers additional help in the differentiation between true and

apparent cases of backward displacement. It is hoped that a report on the value of sectional roentgenography in such problems will be forthcoming.

One cannot overemphasize the essential requirements and value of good quality lateral projections of the lumbosacral spine. Several important anatomical and technical considerations are in order. The sagging phenomenon or lateral flexion of the lumbar spine during recumbency is usually not fully appreciated. Slauson[22] has recently presented a method for clear visualization of the intervertebral spaces and articular margins of the vertebrae. He urges the correct use of the divergent roentgen rays by tilting the roentgen tube in accordance with the radii between the target and the mid-sagittal plane of the patient's spine at different levels, thereby utilizing sagging of the spine to good advantage. Gianturco[8] had previously described a somewhat similar procedure. Since some degree of rotation usually occurs with lateral flexion of the spine, the posterior borders of the vertebrae, expecially of the fifth lumbar vertebra, would not be sharply defined and would result in double posterior borders. Thus in many cases retrodisplacement is simulated. There can be little doubt that many cases in the literature actually represent apparent retrodisplacement due to "staircase" effect. For these reasons, we prefer a true lateral spot roentgenogram of the lumbosacral junction or any other vertebral junction with the central ray perpendicular to the mid-sagittal plane of the patient at the desired level. The lateral sagging of the spine should be corrected by adjusting the mid-sagittal plane so that it is parallel to the table top. Of course, there is usually no such problem when the patient is examined in the upright position, unless scoliosis is present. Examination in the erect posture can no longer be considered optional. A comprehensive study of the lumbosacral spine must include projections with the patient standing, preferably according to the program outlined by Knutsson. He advocates upright lateral projections taken with the patient in flexion and extension. He is thus able to discover cases of "incipient disc degeneration" by demonstrating parallel movement of vertebrae in such cases where no other anatomical evidence of disc degeneration is present.

The longest practical target-to-film distance is, of course, preferable in lateral examinations of the lumbosacral spine in order to decrease the distortion factor. In our studies the mid-sagittal plane of the vertebrae was located 15 cm. above the film and the target-to-film distance 38 inches. The amount of distortion was approximately 15–20 per cent.

Since it is often difficult to obtain clearly defined lateral views of the lumbosacral region which are highly desirable in ascertaining whether or not subluxation is present, the suggestions of Wilsey, Holly and Cornwell[29] are helpful. They advocate the use of lead shields which conform to the contour of the patient's back and are placed adjacent to the patient on the roentgen table. These lead shields serve to absorb direct radiation. It is usually not appreciated that the Potter-Bucky diaphragm is a source of scattered radiation in lateral examinations of the lumbosacral spine. Contrary to popular conception, it has also been shown that high kilovoltage is preferable in most phases of roentgenography. High kilvoltage will, of course, yield less contrast, but there is a greater scale of densities resulting in roentgenograms of better quality and of greater diagnostic value. Detail can be enhanced further by employing up to 6–8 mm. aluminum filter or its equivalent.

Willis[28] is of the opinion that anatomical variations at the lumbosacral junction are frequently responsible for the roentgen appearance of backward displacement. With this opinion we concur. Willis in his studies of anatomical specimens found that two-thirds of the museum specimens which he examined showed the anteroposterior diameter of the superior surface of the sacrum to be smaller than the inferior surface of the fifth lumbar vertebra, and he attributes the cause of apparent posterior displacement to this difference. He assumes, how-

FIG. 8. *a*. Inferior view of fifth lumbar vertebral specimen used in experiments with sacra shown in Figures 9, *a* and *b*, 10, *a* and *b*.

b. Lateral view of same specimen showing slight flaring or "skirting" of inferior surface.

ever, that these measured anatomical diameters in all cases are projected on to the roentgenograms, especially in those sacra with concave posterior borders. The question that immediately arises is why do not all of the cases showing such a difference appear as cases of retrodisplacement? We examined roentgenograms of 100 supposedly normal spines and found that the largest majority, or about 80 per cent, showed this variation and discrepancy without evidence of apparent backward slipping. We believe, therefore, that this difference is not responsible for the appearance of backward subluxation in all cases. Unless there is rotation and sagging with this discrepancy, one cannot simulate displacement because the difference in diameter is evenly distributed anteriorly and posteriorly and the central axes of the vertebrae overlap. So little difference actually exists at the articular borders that it is not perceptible on the roentgenograms. In these cases the eye does not readily detect the small difference in diameters because one follows the general curve of the spine. We have not found that the concave border of the first sacral segment is visualized on true lateral projections because the largest anteroposterior diameter instead of the mid-sagittal diameter is projected on films. Concave surfaces per se are not the cause of false backward displacement. In order to check these impressions we examined two sacra, one with a straight posterior border of the first sacral segment (Fig. 9, *a* and *b*) and the other with a concave posterior border (same specimen as used by Willis in his experiments) as shown in Figure 10, *a* and *b*. The same fifth lumbar vertebra (Fig. 8, *a* and *b*) was used throughout our experimental work with either sacrum. The intervertebral disc was simulated by a fashioned felt pad of disc proportions. Roentgenograms of the lumbosacral specimens thus described were made at 38 inches target-to-film distance with the mid-sagittal plane of the specimens 15 cm. above the cassette. Exposures were made with the central ray at the fourth and fifth lumbar intervertebral levels. The distortion was approximately 13 per cent.

A true lateral projection (Fig. 11*a*) of the sacrum with the concave posterior first sacral segment (hereafter referred to as "concave" sacrum) reveals only one posterior border; the concavity is not visualized. With small lead markers in the mid-sagittal plane on the posterior aspects of the fifth

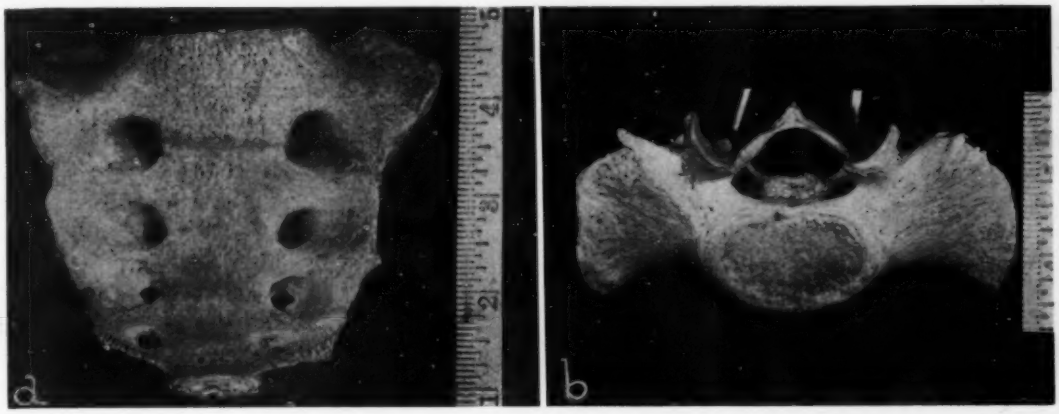

Fig. 9. *a* and *b*. Frontal and top views of sacrum, the first segment of which possesses a straight posterior border.

lumbar and the first sacral segments (Fig. 11*b*) the concavity of the sacrum is anterior to the actual posterior border of the sacrum on the roentgenogram. In Figure 11, *a* and *b* the central ray is at the level of the lumbosacral disc.

The effect of slight rotation of the "concave" sacral specimen is well demonstrated in Figure 11*c*, a double posterior sacral border being created by the concavity anteriorly. The illusion of posterior displacement is, in great measure, due to "flaring" or "skirting" of the fifth lumbar vertebra which is normally present laterally. With slight rotation the "skirting" is thrown into relief and the inferior articular margin appears to project backward beyond the corresponding posterior sacral border.

Shift of the central ray to the level of the fourth lumbar intervertebral space causes apparent narrowing of this disc and creates ovoid images of the adjacent articular surfaces of the sacrum and fifth lumbar vertebra (Fig. 11*d*). The effect of slight rotation in the production of apparent backward displacement is illustrated in Figure 11, *e* and *f*.

The experiments cited above were repeated with the "straight" sacral segment (Fig. 9, *a* and *b*). With the central ray at the level of the lumbosacral junction one posterior border is again visualized (Fig. 12*a*). There was, however, one difference between the appearance of the "concave"

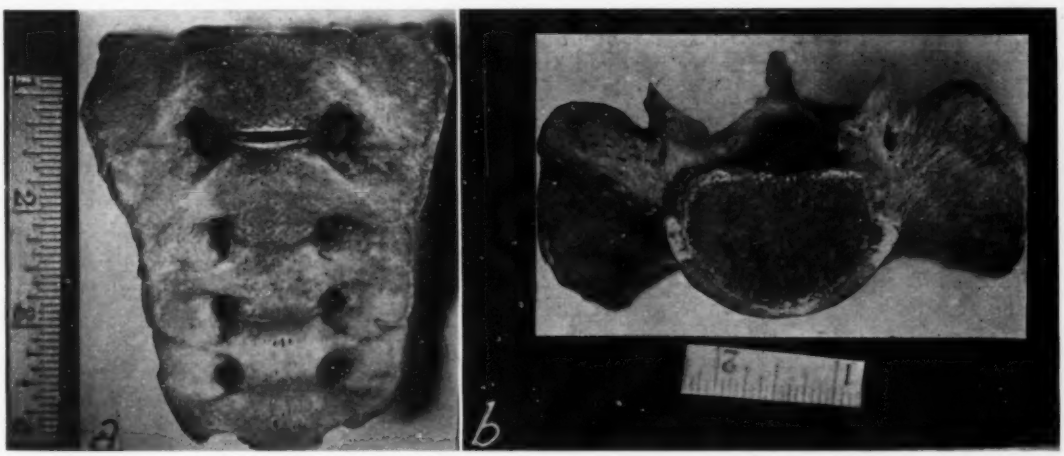

Fig. 10. *a* and *b*. Anterior and superior views of the other sacrum. Posterior border of first sacral segment is concave. (Courtesy of Dr. Hoerr of Hammond Museum. Same specimen used by Dr. Willis.)

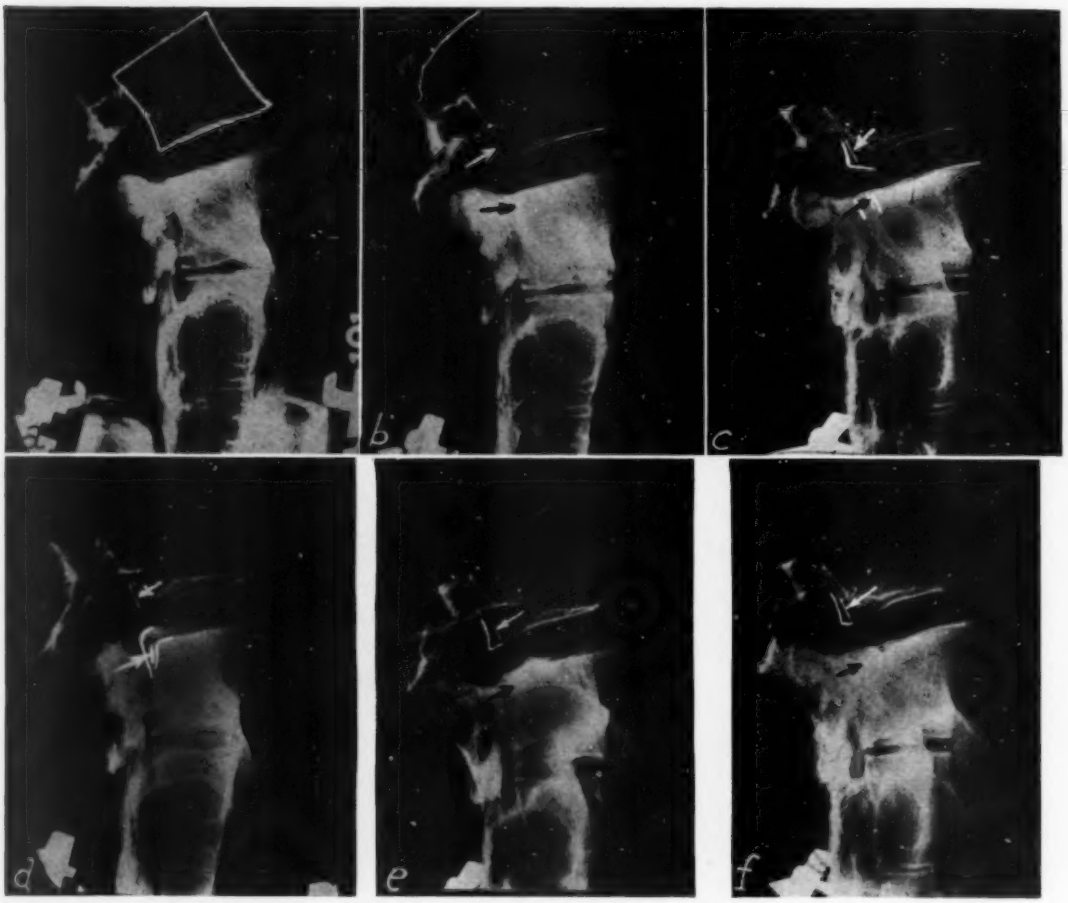

FIG. 11. *a*. Perfect lateral projection of lumbosacral specimen formed by fifth lumbar vertebra shown in Figure 8, *a* and *b* and "concave" sacrum shown in Figures 10, *a* and *b*. Concavity of posterior surface of first sacral segment is not visualized. The intervertebral disc was fashioned of orthopedic felt material. The central ray is at level of lumbosacral junction. (Specimen measurements: mid-sagittal diameters of top of sacrum and inferior surface of fifth lumbar vertebra are 28 and 29 mm., respectively. The comparable film measurements are 35 and 36 mm., indicating approximately 20 per cent distortion. (Retouched.)

b. Lateral view of same specimen as in *a* with lead markers (arrows) placed on posterior aspects of fifth lumbar vertebra and sacrum (concave posterior border) in mid-sagittal plane. Central ray is at level of lumbosacral joint. One posterior upper sacral border is visualized and no parallel displacement is disclosed.

c. Lateral projection of specimen with central ray still at level of lumbosacral junction but specimen is rotated 10 degrees resulting in apparent backward displacement. Lead marker (arrow) on sacrum delineates concavity and double posterior sacral border. The flaring of the posteroinferior aspect of the fifth lumbar thrown into relief by the slight rotation is responsible for appearance of apparent retrodisplacement. Lead marker (arrow) shows true posterior limits of fifth lumbar vertebra. (Retouched.)

d. True lateral view of specimen with central ray shifted to level of the fourth lumbar vertebra, resulting in apparent narrowing of the intervertebral space. (Retouched.)

e. Apparent backward displacement produced by 10 degrees rotation of specimen, central ray at level of fourth lumbar vertebra. True location of posterior margins of fifth lumbar and first sacral segments is indicated by the lead markers. (Retouched.)

f. Same specimen with rotation and sagging (slight lateral flexion) of lumbosacral junction, central ray at level of fourth lumbar vertebra, again producing apparent backward displacement. The divergent roentgen rays are parallel to articular margins; therefore, the intervertebral space does not appear narrowed. (Retouched.)

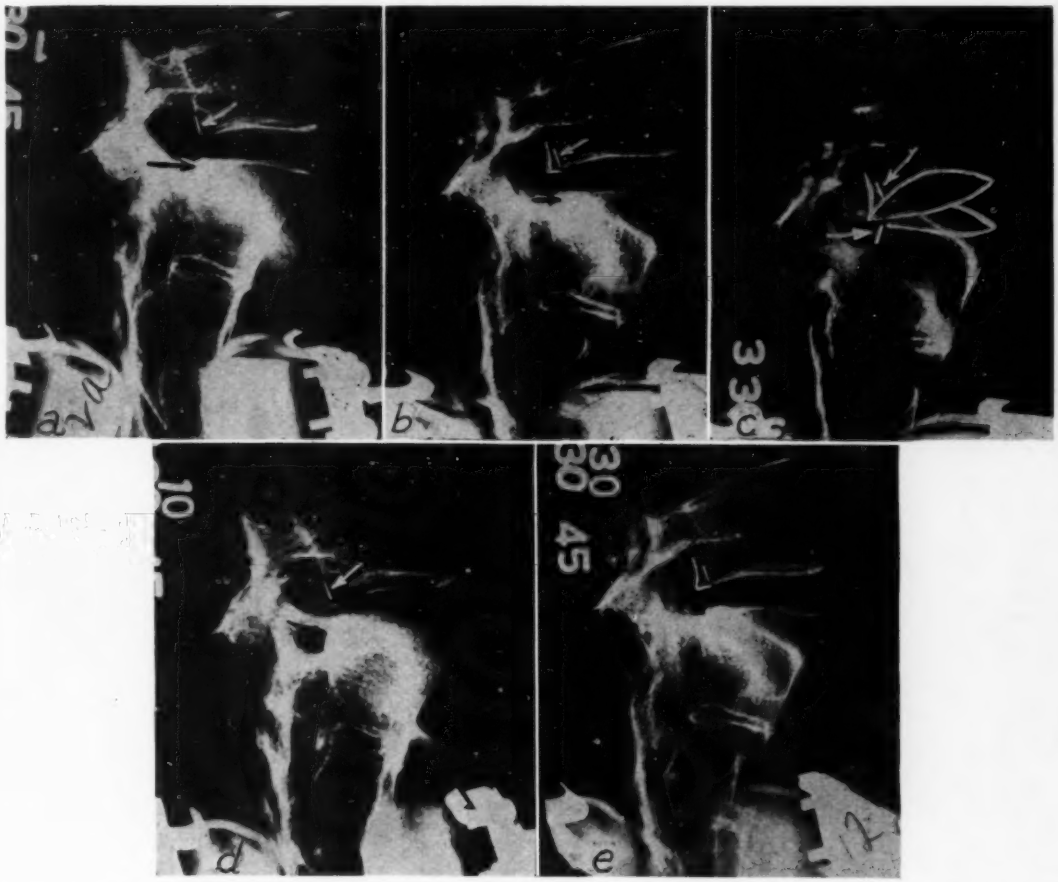

Fig. 12. *a*. True lateral projection of lumbosacral specimen, the posterior upper sacral border of which is straight (Fig. 9,*a* and *b*). The central ray is directed at and through the lumbosacral junction. Lead markers (arrows) on posterior borders in mid-sagittal plane. Roentgen appearance identical with that in Figure 11*b* where the posterior sacral border is concave, thus indicating that the contour of the posterior surface of the sacrum does not influence apparent parallel displacement in true lateral projections.

b. Lateral projection of same specimen shown in *a* with approximately 10 degrees rotation shows single posterior sacral outline but flaring of fifth lumbar vertebra causes apparent posterior displacement. (Retouched.)

c. Lateral projection with sagging and rotation again shows increased apparent posterior displacement described in *b*. In addition, there is apparent narrowing of lumbosacral space. (Retouched.)

d. Technique same as in *a* but central ray is shifted to level of fourth lumbar vertebra. Note apparent narrowing of posterior portion of disc but no posterior displacement. (Retouched.) Lead markers are delineated by arrows.

e. Conditions identical with those in *c*, but central ray is at the level of the fourth lumbar vertebra. Note apparent displacement of fifth lumbar vertebra but the lumbosacral disc now appears to be of normal width, divergent roentgen rays being responsible for clear visualization of the interspace.

and "straight" sacral segments. As the reader will recall, slight rotation of the "concave" sacrum produced a double posterior sacral border while rotation of the straight sacrum resulted in only a single posterior sacral border (Fig. 12*b*). On the true lateral projection the posterior margin of the first sacral segment is represented by a single line, and posterior displacement is simulated by the flaring of the inferior articular portion of the fifth lumbar vertebra. The addition of sagging to the effect of rotation, as one would expect, serves to exaggerate the illusion of posterior displacement and once again the intervertebral space appears narrowed (Fig. 12*c*).

Shifting the roentgen tube or central ray from the level of the fifth lumbar to the fourth lumbar intervertebral space fails to create the illusion of backward displacement (Fig. 12*d*), but the intervertebral space is narrowed. Rotation and sagging again serve to produce apparent subluxation (Fig. 12*e*) but the intervertebral space, due to utilization of the divergent roentgen-ray beam, is not narrowed.

Our studies were continued by wedging one-half of the lumbosacral disc, in order to imitate conditions in vivo. Additional felt was introduced on one side of the intervertebral space in order to duplicate living conditions when a patient is examined in lateral recumbency. The first studies with this specimen were made with the mid-sagittal plane of the sacrum parallel to the film, while the corresponding plane of the fifth lumbar vertebra was tilted. With the central ray focused at the lumbosacral joint, posterior slipping is simulated by visualization of the fifth lumbar flaring posterolaterally (Fig. 13*a*). Thus, the most posterior margin of the inferior aspect of the fifth lumbar vertebra is projected behind the corresponding sacral margin. The intervertebral space also appears to be narrowed. These findings are increased when the entire specimen is rotated 5 to 10 degrees (Fig. 13*b*). Later the entire specimen with wedged lumbosacral disc was tilted so that the mid-sagittal plane of the sacrum produced an angle of 10 to 15 degrees with the plane of the table top. Here too posterior subluxation is simulated (Fig. 13*c*) but the articular margins of the fifth lumbar and first sacral segments are sharper and more distinct. The divergent roentgen-ray beam is utilized and distortion of these structures is reduced.

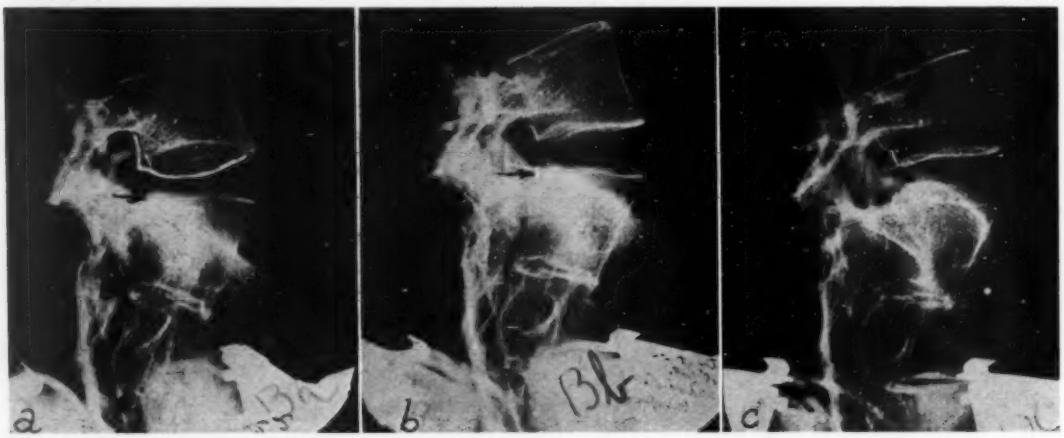

FIG. 13. *a*. Lateral projection after lateral wedging of felt disc, simulating sagging (lateral flexion), and with slight rotation of the specimen (sacrum with straight posterior border) shows apparent posterior displacement due to the posterior and lateral flaring of the fifth lumbar vertebra. The central ray is at level of lumbosacral joint. Note apparent narrowing of the disc. (Retouched.)

b. Specimen same as in *a* but central ray is shifted to level of fourth lumbar vertebra. The projection again reveals apparent backward displacement. (Retouched.)

c. Same conditions as in *b* plus rotation of specimen exaggerates apparent retrodisplacement. Wedging of disc as described in *a* and *b* present.

Similar studies were carried out with human subjects, cases selected from a group of nurses whose hip measurements were a good deal greater than their waist diameters. These subjects had no back complaints. Miss D. S., aged nineteen, a student nurse, measured 34 cm. between the femoral trochanters and had a waist diameter of 26 cm. To further exaggerate this difference, the hips were elevated off the table for a distance of several centimeters. The lateral projection (Fig. 14*a*) shows ap-

parent retrodisplacement of the fifth lumbar vertebra and narrowing of the fifth lumbar intervertebral space. At re-examination with the central ray at the level of the lumbosacral junction, and with the spine straightened on the table, the apparent backward slipping at the lumbosacral level disappeared (Fig. 14*b*).

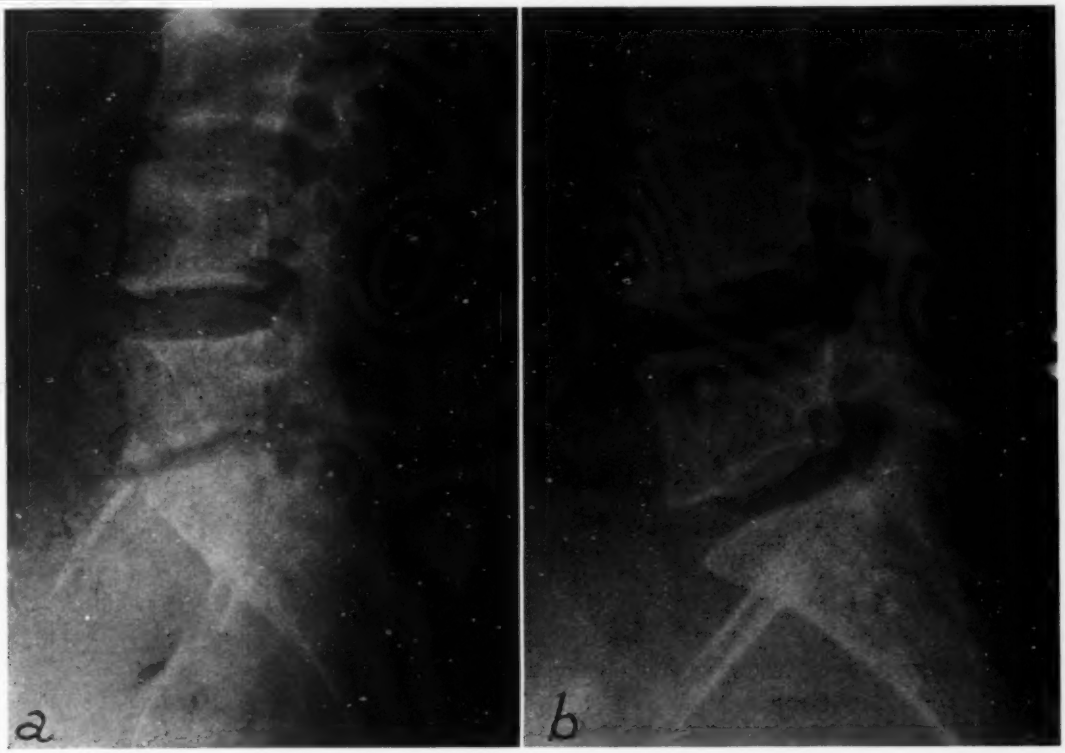

Fig. 14. *a*. Miss D. S., aged nineteen, student nurse. The transverse diameter of the pelvis measured 34 cm. while the transverse diameter at the waistline measured 26 cm. Lateral roentgenogram taken with hips elevated off table top for approximately 9 cm. in order to produce slight sagging in lower lumbar region. Note apparent narrowing of the lumbosacral joint and apparent posterior displacement of fifth lumbar vertebra. Results comparable to experimental findings shown in previous illustrations.

b. Lateral roentgenogram of same patient, the hips no longer elevated and sagging eliminated, with central ray aimed at the lumbosacral junction. Neither retrodisplacement nor apparent narrowing of disc is observed.

Another illustration of this principle is shown by a patient, aged thirty-five, who, in the routine lateral recumbent roentgenogram of the lumbosacral spine, exhibited apparent posterior slipping and narrowing of the intervertebral space (Fig. 15*a*). The upright spot roentgenogram of the lumbosacral joint, which eliminated the factor of lateral flexion, shows no abnormality (Fig. 15*b*).

The effect of flaring of the posteroinferior margin of the fifth lumbar vertebra is well demonstrated in the patient, Mrs. S. S., aged twenty-six, whose lateral roentgenogram shows apparent retrodisplacement (Fig. 16) but the apophyseal joints are normal in width. In this case one cannot make a diagnosis of true retrodisplacement.

There are cases in which no anatomical factors, such as flaring of the fifth lumbar vertebra posteriorly, bevelled posterosuperior sacral margin, etc., are present, and yet retrodisplacement is simulated. Such a case is represented in Figure 17, Mr. M. R., aged forty, whose articular facets in the lumbosacral region face anteriorly and posteriorly. The apophyseal joints are well visualized and show no appreciable widen-

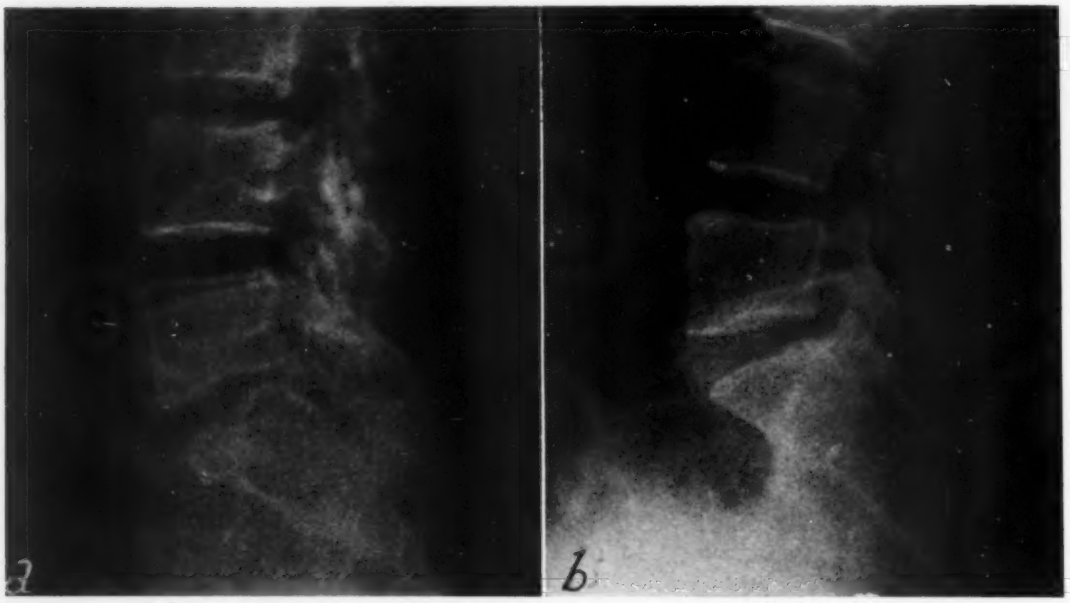

FIG. 15. *a*. Mrs. J. D., aged thirty-five. Lateral view in recumbency showing apparent posterior narrowing of lumbosacral interspace and pseudo-backward displacement of fifth lumbar vertebra.

b. Same patient examined in vertical position, lateral sagging being eliminated, shows normal lumbosacral region.

FIG. 16. Mrs. S. S., aged twenty-six. Apparent backward displacement due to unusually marked flaring of posteroinferior margin of fifth lumbar vertebra.

FIG. 17. Mr. M. R., aged forty. Apparent backward displacement with normal apophyseal joint width. The facets face anteriorly and posteriorly. Roentgen measurements of superior surface of sacrum and inferior surface of fifth lumbar vertebra are 40 and 44 mm., respectively. Note, however, that anterior margins do not overlap and interspace is of normal width. In this case the discrepancy of the anteroposterior diameters is cause of apparent retrodisplacement.

ing. One must therefore consider such a case as apparent and due to an optical illusion as described by Willis. The measurements of the adjacent surfaces of the fifth lumbar and first sacral segments are 44 and 40 mm., respectively. Rarely does one observe a bevelled posterosuperior border of the sacrum (Fig. 19) which obviously, by virtue of the fact that the articular surface is shortened in the anteroposterior axis, serves to create the illusion of posterior displacement, but the general curve of the lumbosacral spine is smooth and the apophyseal joint spaces are normal in width.

An excellent example of carelessness on the part of a technician is demonstrated by the next pair of roentgenograms of the same patient. When asked to "spot" over the lumbosacral junction, the technician reduced the target-to-film distance and obtained a markedly distorted image The

FIG. 18. Mr. G. G., aged fifty-two. Lateral view showing apparent slight displacement of fourth lumbar vertebra on fifth lumbar vertebra because of tapering of fifth lumbar vertebral body, the latter assuming sacral proportions or characteristics. Narrowing of the lumbosacral joint is due to sacralization of the fifth lumbar vertebra.

FIG. 19. Mrs. B. R., aged twenty-six. Lateral projection showing bevelled posterosuperior margin of first sacral segment which is responsible for 4 cm. difference in the anteroposterior diameters of the opposing surfaces at the lumbosacral junction. No true backward displacement is present.

effect of this short target-to-film distance is illustrated in Figure 20*a*, where marked distortion of the diameters of the vertebrae is obtained and posterior subluxation is simulated. The other upright lateral projection (Fig. 20*b*) shows smaller vertebral images and less, if any, apparent slipping. The apophyseal joints are not widened.

Flaring of the inferior border of the fifth lumbar vertebra has received little attention as a possible factor in the causation of confusing shadows on roentgenograms. Normal anatomical flaring is present, for the most part, on the lateral aspects. If the spine is rotated, this flaring is thrown into relief and becomes more apparent. This flaring, when contrasted against the adjacent posterior border of the sacrum, simulates retrodisplacement, and lends additional width to the mid-sagittal diameter of the inferior surface of the fifth lumbar vertebra. Along similar lines arthritic lipping can produce the same effect. It has

FIG. 20. *a.* Mr. A. S., aged fifty-three. Upright lateral view showing apparent backward displacement and narrowed space in lumbosacral region due to short target-to-film distance and slight rotation.
b. Same case. Less distortion and less rotation effect because of greater target-to-film distance.

been our experience that overlapping bone shadows in many instances confuse and obscure the normal anatomical landmarks on the roentgenograms. We found that the posterior border of the sacrum is simulated by various overlapping bone structures on the lateral projection. These disturbing shadows must be analyzed and resolved before an accurate interpretation can be advanced. The lumbosacral junction is often difficult of visualization in the lateral view due to a deeply set last lumbar vertebra. In such event, the overlapping iliac crests and wings obscure the lumbosacral junction. It occurs to us that in such cases planigraphy in the lateral position would be of great value.

One cannot, therefore, by any stretch of the imagination, exaggerate the potentialities of anatomical and technical variations, so far as they affect roentgen visualization of the lumbar vertebrae and simulate pathological conditions.

CRITERIA FOR THE ROENTGEN DIAGNOSIS OF RETRODISPLACEMENT OF LUMBAR VERTEBRAE

We have attempted to enumerate a set of criteria for a diagnosis of posterior displacement of lumbar vertebrae. These criteria were formulated following a critical analysis of the medical literature and rather extensive study of a large series of roentgenograms of backward displacement of lumbar vertebrae. It should be apparent and appreciated that one will not expect or discover all of the signs to be present at any one lumbar level, the roentgen features varying considerably from the first lumbar to the lumbosacral level.

1. *Degeneration with or without actual narrowing of the interspace is essential.* Roentgen signs of disc degeneration are as follows: (*a*) narrowing of the intervertebral space; (*b*) reactive changes at articular margins of the vertebral segments; (*c*) vacuum phenomenon; (*d*) calcification of

the intervertebral disc; (*e*) instability—abnormal relation of vertebrae, such as retrodisplacement, pseudospondylolisthesis, etc.; (*f*) abnormal motion of vertebrae; (*g*) alteration of the lumbar curve.

2. *The posterior border, as well as the anterior border, of the cephalad vertebral body must be displaced posterior to the corresponding portion of the caudad vertebra.* The continuity of the lumbar curve is broken.

3. *Narrowing of the intervertebral foramina—at least in the anteroposterior direction.* If the intervertebral space is decreased, vertical narrowing of the intervertebral foramina will occur. The anteroposterior narrowing of these foramina results in an "hour-glass" appearance. This encroachment is due to approximation of the posteroinferior margin of the cephalad vertebral body and the superior articular process of the adjacent caudad vertebra.

4. *Displacement of the facets and/or widening of the apophyseal joint space must be present.* If the facets are of the internal-external type, widening of the overlapping articular processes in the sagittal plane will be disclosed. If the facets face anteriorly and posteriorly, widening of the joint space must be demonstrated.

5. *Prominence or protrusion of the spinous process of the displaced vertebra on the sagittal projection.*

6. *Alteration of the lumbar curve.*

7. *Roentgen signs of retrodisplacement not eliminated by technical means.*

SUMMARY AND CONCLUSIONS

A review of the literature on the subject of retrodisplacement of vertebrae is presented. An attempt has been made to crystallize the various concepts at present existent with reference to this condition. We have found that backward displacement of lumbar vertebrae, the fifth lumbar vertebra included, is a pathological entity which is encountered with sufficient frequency to deserve greater recognition.

On the basis of our anatomical and roentgenological studies an etiological classification of backward slipping of lumbar vertebrae is offered. The etiological factors responsible for true backward displacement are degenerative processes, disease, trauma and/or congenital anomalies. Criteria for distinguishing and segregating such cases of true backward displacement from those due to anatomical and technical factors—apparent retrodisplacement—are listed.

In the light of recent advances in roentgen technique and interpretation a more comprehensive roentgen examination of the lumbar spine is recommended if cases of backward displacement are not to be overlooked.

We wish to express our thanks to Dr. N. Hoerr, Western Reserve Medical School, for the opportunity of examining sacrum No. 1097 of the Hammond Museum.

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OSTEOCHONDRITIS OF THE INTERNAL CUNEIFORM, BILATERAL

CASE REPORT

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THE osteochondritides have been widely presented and covered in the literature, demonstrating that the condition occurs mainly in the spine and extremities. The etiology is not definitely known but it is thought to be due to a disturbance of the nutritional status locally, or upon an endocrine basis, or possibly trauma of a sort, producing a disturbance in the chondral ossification with aseptic necrosis in the epiphysis. Suffice it to say that osteochondritis is rarer in certain areas and with this in mind this case report is presented because of the paucity of like cases in the literature.

Until 1933 a study of the literature revealed no reports on osteochondritis of the internal cuneiform. Then Buchman[1] presented a study of 2 cases of osteochondritis of the internal cuneiform associated with like changes in the tarsal scaphoid bilaterally in one case, and the second case presented the same findings in the right foot.

Both of the above patients were males, each six and one-half years old. The first case gave a history of slight trauma brought about by twisting the foot following a misstep. The second case gave no history of trauma. By chance only his right foot was roentgenographed for comparison with the first case.

FIG. 1. Dorsoventral view showing irregularity and fragmentation of the internal cuneiforms bilaterally with condensation and rarefaction. Flattening of the scaphoids with irregularity of outline and condensation and rarefaction is also noted bilaterally.

Haboush[2] about the same time presented one case of a white male, aged four and one-half years, with bilateral involvement of the internal cuneiform and also the tarsal scaphoids. No definite history of trauma was elicited in this case. The complaint was pain in the instep with limping on the left side.

A further check of the literature to date reveals no other reports, so with this in mind a fourth case is offered.

FIG. 2 and 3. Oblique views again show the marked irregularity of outline of the cuneiforms, the condensation and rarefaction. The flattening, irregularity, condensation and rarefaction are also noted in the scaphoids.

REPORT OF CASE

A mother presented her four year old child, a white male, who complained of pain over the dorsum of the left foot which was more noticeable after running. Patient also had a tendency to walk on the outside of the feet and would wear down the outer half of the heels. This factor had been especially noted for the previous three months.

History elicited no trauma and physical examination revealed no tenderness or deformity of the feet. No complaints were noted in the right foot which was roentgenographed for comparison. Patient was to return at intervals for further check for roentgen changes but failed to do so.

Roentgenographic examination (Fig. 1) of both feet showed an irregularity of the outline of the internal cuneiforms both of which appear smaller in size than the adjacent tarsal bones with the exception of the scaphoids. The center of each cuneiform shows slight condensation and the inner half some rarefaction. The oblique views (Fig. 2 and 3) show a greater irregularity of outline of the right cuneiform than the left, the latter being the side of complaint. The scaphoids of both feet are smaller than normal, flattened and irregular, both showing some condensation and rarefaction. No significant changes are noted in the remaining bones of the feet.

A comparison of this case with the previous 3 cases presented by Buchman and by Haboush shows a marked similarity in the findings. In this case no history of trauma was found. The same findings were noted in 2 of the other 3 reported cases. All of the patients have been males ranging in age from four to six and one-half years of age, and the presence of bilateral involvement in 3 of the cases with complaints only on one side seems to rule out trauma as a definite etiological factor in this small group.

SUMMARY

A single case of osteochondritis of the internal cuneiform of both feet in association with osteochondritis of the tarsal scaphoids in a white male of four years of age is presented making a total of four cases reported in the literature.

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THE TREATMENT OF RECURRENCES AND EVALUATION OF CRITERIA FOR THE SELECTION OF TREATMENT OF CANCER OF THE LARYNX*

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THE initial treatment of cancer of the larynx by laryngofissure, laryngectomy and irradiation has been widely discussed in the American and foreign literature. There is no one method by which all cases of cancer of the larynx can be treated and the results better than the combined results of these three methods. Some laryngologists, surgeons and radiologists consider these methods competitive. This concept is erroneous. The only consideration should be the patient and what treatment modality will give him the greatest chance of obtaining a complete arrest or cure of his disease. All factors should be weighed carefully, and the established criteria should determine the best method of treatment.

All three methods have their failures. The patients who are not cured by these procedures and who develop recurrences or metastases present problems of important decision and management. Not infrequently these patients are considered hopeless and are given palliative treatment only. Many of this group, if properly and adequately treated, could be cured.

The purpose of this paper is to review the experiences which we have had at Temple University Hospital in the treatment of recurrences and metastases of cancer of the larynx, and to evaluate the criteria upon which the selection of treatment is based.

RECURRENCES AFTER LARYNGOFISSURE

The "laryngofissure" operation means the procedure by which the thyroid cartilage is divided and the cancer involved tissue is resected subperichondrially. The reported cures for this procedure are 80 to 85 per cent.[8]

Following laryngofissure, recurrences are observed in about 17 per cent of the cases. In another 3 to 5 per cent metastases are the cause of death. In an attempt to explain a possible cause for recurrence, Broyles[3] calls attention to the anatomy. The tendon at the anterior commissure is firmly attached to the cartilage. Laterally, the perichondrium of the thyroid cartilage may be easily separated but at the anterior commissure, where the tendon joins the cartilage, there is no line of cleavage. It is here that residual disease may give rise to an early recurrence. To prevent this, Broyles advises the removal of the diseased vocal cord, the anterior ridge or crista of the thyroid cartilage, and the anterior portion of the healthy cord.

In a series of 188 cases of cancer of the larynx treated by all methods (laryngofissure, laryngectomy and irradiation) from 1930 to 1937 inclusive, studied and analyzed by Jackson, Blady and Norris recently, there were 12 failures in a group of 59 patients treated by laryngofissure and followed for a period of five years and longer.[11,12] Ten of these failures developed recurrences and only 4 of these patients received additional treatment; of these 4, 3 are living and free of disease (Table 1). In 6 cases no treatment was administered. It is probable that if the recurrence in these 6 patients had been discovered early, and proper treatment instituted, some of them might have survived.

In a series of cases observed from 1930 to 1941 inclusive, 5 patients were treated by irradiation for a recurrence after laryngofissure. Two patients of this group survived seven and seventeen years respectively, after the initial laryngofissure and subse-

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TABLE I

ANALYSIS OF FAILURES IN 12 CASES OF LARYNGOFISSURE

A. Developed recurrences		10 cases
1. Dead of disease	5	
2. Dead of disease; treated by laryngectomy	1	
3. Living and well; no evidence of disease, treated by laryngectomy	1	
4. Living and well; no evidence of disease, treated by roentgen irradiation	2	
5. Lost with disease	1	
Five year salvage of recurrences 3 cases, 30%		
B. Developed metastases and died of disease		2 cases

From 1930 to 1937, 71 laryngofissure operations were performed in the Chevalier Jackson Bronchoscopic Clinic of Temple University Hospital. In this group there were 10 recurrences. The recurrence rate was determined as follows: 7 patients died of other causes without evidence of recurrent or metastatic disease prior to five year survival; an additional 5 were lost to follow-up. Subtracting these cases, leaves a determinate group of 59 cases. Recurrence rate—10/59=17 per cent.

quent irradiation (Table II).

Based on the above results and on observations in cases treated since 1941, but who are not being reported in this series, we feel that *recurrence after a laryngofissure operation can be successfully treated either by laryngectomy or by roentgen irradiation.* It is most important that the diagnosis of a recurrence be made early and that it is verified by histopathologic study.

The decision as to whether the recurrence should be treated by laryngectomy or irradiation is not always an easy one. A laryngofissure wound heals by scar tissue. Because of this, ofttimes clinically it is impossible to determine whether there is deep infiltration and involvement of the cartilage or whether the recurrence is superficial. When there is suggestive evidence of invasion of cartilage, or if the lesion is subglottic, laryngectomy is advised. Conversely, if the recurrence has the appearance of being superficial, then radiation is the treatment method of choice. In the consideration of the latter decision we again call attention to Broders' grading of tumors. In our experience, squamous cell carcinoma, Grade 3 is less radiosensitive than Grades 1 2 and 4. We prefer laryngectomy to radiation in the treatment of squamous cell carcinoma, Grade 3 lesions.

TREATMENT OF RECURRENCES AFTER IRRADIATION

Eighty-one patients were treated by roentgen irradiation in the period from 1931 to 1941 inclusive, and are the bases of the present study. Fifty-six of these cases were classified intrinsic, and 25 extrinsic. In the intrinsic group there were 13 recurrences, (23 per cent) and in the extrinsic, 6 recurrences (24 per cent).

An analysis of the 19 recurrences reveals that 14 received additional treatment. Five patients survived five or more years after treatment of the recurrence for a survival rate of 26 per cent.

In the intrinsic group, 6 patients had a

TABLE II

RECURRENCES AFTER LARYNGOFISSURE TREATED BY IRRADIATION

Case No.	Histopathologic Grade	No. of Months Recurrence after Laryngofissure	Survival after Roentgen Irradiation for Recurrence	Total Survival Period
1 G.B.	1	2	18 mo.	20 mo.
2 E.H.	2	31	51 mo.	82 mo.
3 S.I.	4	3	24 mo.	27 mo.
4 E.C.	4	8	26 mo.	34 mo.
5 H.N.	2	89	9 yr. living and well	17 yr. living and well

squamous cell carcinoma, Grade 2, and 7 had Grade 3.

Four patients with Grade 2 cancer received a second course of roentgen irradiation and 2 of these survived eight and eleven and one-half years respectively. One is still living, free of disease, and the other survived a total of eleven and one-half years and died of other causes at the age of eighty-six. The remaining 2 died of their disease five and six months after treatment of the recurrence. A fifth patient had a laryngectomy performed for a recurrence and survived an additional thirty months during which time the tumor recurred and metastasized extensively.

Of the 7 cases of squamous cell carcinoma Grade 3, 5 received a second course of roentgen irradiation. One patient was alive and free of recurrent or metastatic disease a total of fifty-eight months when lost. It can be presumed that this patient survived a total of five years. Efforts are still being expended to locate this patient in another country. Another patient with a recurrence received a second course of 6,000 roentgens, measured in air, to the anterior neck through a 7 cm. portal directed at the larynx. He developed a second recurrence nine months later, for which a laryngectomy was performed. He is now living and free of disease fifty-two months after the laryngectomy. The other 3 are dead of disease, with an average total survival time of thirty-seven months, and an average survival time after the recurrence of twelve months. Two received no treatment and survived six and twenty-one months respectively, after the diagnosis of recurrence.

Of the group of 6 patients with recur-

Table III

RESULT OF TREATMENT OF RECURRENCES AFTER IRRADIATION

Treatment of Recurrence by	Number of Cases	Five Year Survival
Roentgen irradiation	12	4
Laryngectomy	2	1
None	3	0
Not known	2	0

Table IV

ANALYSIS OF RECURRENCES IN INTRINSIC GROUP TREATED INITIALLY BY ROENTGEN IRRADIATION

Case	Age	Histopathologic Grade	Metastases	Recurrence Time after Irradiation	Treatment of Recurrence	Survival after Recurrence	Total Survival Period
1 G.C.	74	2	No	8 yr.	X-ray	42 mo.	138 mo.*
2 J.L.	44	2	Yes	5 mo.	X-ray	6 mo.	13 mo.
3 S.H.		2	—	5½ yr.	Unknown		
4 C.M.	50	2	No	10 mo.	X-ray	84 mo.	94 mo.†
5 F.D.	72	2	No	3 mo.	X-ray	5 mo.	8 mo.
6 G.F.	68	2	Yes	22 mo.	Laryngectomy	30 mo.	52 mo.
7 M.A.	71	3	No	14 mo.	None	21 mo.	32 mo.
8 E.H.	47	3	Yes	51 mo.	X-ray	5 mo.	56 mo.
9 R.T.	66	3	Yes	10 mo.	X-ray	18 mo.	28 mo.
10 F.Mc.	80	3	No	14 mo.	X-ray	12 mo.	26 mo.
11 Dr.R.	53	3	No	15 mo.	None	6 mo.	21 mo.
12 T.S.	39	3	No	6 mo.	1st: x-ray; 2nd: 9 mo. later laryngectomy	52 mo.†	67 mo.†
13 J.H.	54	3	Yes	22 mo.	X-ray	36 mo.	58 mo.‡

* Died of other causes without evidence of recurrence of metastases.
† Alive and free of disease.
‡ Lost to follow-up fifty-eight months after treatment, without evidence of recurrence of metastases (living in foreign country).

rences in the extrinsic group, 4 received a second course of roentgen treatments. One of these patients survived a total of twelve years after irradiation and died of accidental illuminating gas asphyxiation at the age of seventy-six (Table v).

It is of interest to note that a total of 13 patients received a second course of intensive radiation for recurrence. In each case, the minimal dosage of the second course was about 3,000 roentgens, measured in air, delivered to each side of the neck. In this group sloughing of the laryngeal cartilages was observed in only one patient, and when last seen he was alive and free of disease five years after the initial treatment. If, therefore, irradiation, of itself, produces sloughing, this group certainly would have had the opportunity to demonstrate this fact. We have observed 2 other patients with sloughing of the laryngeal cartilages.[1] Both patients received only one course of roentgen irradiation. Sloughing of laryngeal cartilage is due, we feel, to the fact that the tumor has infiltrated the periosteum or has invaded the cartilage and bone itself. As the tumor regresses under irradiation, the cartilage and bone are exposed, infection of the cartilage and bone occurs and sloughing is then inevitable. Based on the above reported results and experiences to date, *we do not feel that one course of irradiation, delivering a cancericidal tumor dose, or even a second similar course, when used in the selected case, will produce the undesirable complication of radionecrosis.*

TABLE V

ANALYSIS OF RECURRENCES IN EXTRINSIC GROUP TREATED INITIALLY BY ROENTGEN IRRADIATION

Case	Age	Histopathologic Grade	Metastases	Recurrence Time Irradiation in Months	Treatment of Recurrence	Survival after Recurrence in Months	Total Survival Period in Months
1 C.A.	63	3	No	4	None	6	10
2 L.B.	60	4	No	46	X-ray	144	190*
3 J.Mc.	46	3	Yes	28	X-ray	5	33
4 T.W.	81	2	No	6	X-ray	1	7
5 G.K.	54	2	Yes	5	X-ray	2	7
6 P.L.	70	3	No	6	None	2	8

* Died of accidental illuminating gas asphyxiation at age of seventy-six without evidence of recurrence or metastases.

Surgery following intensive roentgen irradation is made slightly more difficult because of fibrosis. This, however, should never be the cause of hesitation or the cause for refusal to perform surgery. In the literature many statements have been made by prominent surgeons and laryngologists to the effect that surgery is very difficult after irradiation. Because of this some even refuse to perform the necessary surgery. I agree with the statement only in that irradiation makes the surgery more tedious and time consuming. Nowhere is this better demonstrated than in radical neck dissections following intensive irradiation for metastases.

We feel that *recurrences after roentgen irradiation can be successfully treated by a second course of irradiation or by laryngectomy.* Recently, one patient with an intrinsic lesion was treated by laryngofissure for a recurrence two and one-half years following irradiation. This patient is now well and free of disease, two years after this procedure. Davis[6] reports 2 cases of recurrence after teleradium for intrinsic lesions, treated by laryngofissure and free of disease five years later. It must be cautioned that laryngofissure for a recurrence should never

be employed unless the lesion is small and does not extend beyond the involved cord.

RECURRENCES AFTER LARYNGECTOMY

In our experience, recurrence after laryngectomy is a hopeless condition. Fifteen patients with recurrences after laryngectomy were observed and treated and none survived. The average survival time in this group was nine and one-half months. In all cases in which irradiation was employed, a tumor dosage of about 6 to 10 threshold erythema doses was delivered. A temporary regression was observed in all cases; however, in two to four months recurrent activity was present. Some, in addition to the recurrence, developed metastases.

In a number of these cases we attempted to remove the recurrence surgically but without success. In other cases interstitial radon was implanted and external irradiation supplemented the surgical procedure, again without success. In more recent cases surgery alone has been utilized but so far the results have been discouraging. In one case, the pharynx and cervical esophagus were completely resected; several months later the patient developed a recurrence in the upper mediastinal portion of the esophagus and later developed metastases. It is my opinion that when a recurrence after laryngectomy is suspected, immediate extensive surgery is indicated. The surgical procedure will require a resection of the pharynx and cervical esophagus, combined with a partial neck dissection. If any success is to be attained in this group of cases, it will only be because of prompt radical surgery. For success it is most important that these recurrences are discovered early. The recurrence rate for laryngectomy is 24 per cent.

CRITERIA FOR SELECTION OF TREATMENT

When these statistics of recurrences are analyzed it becomes apparent that in addition to the recognized criteria,[5,10,15] it is necessary to consider the factor of possible recurrence and its prognosis in the selection of the treatment procedure. The results of treatment by irradiation and laryngectomy, based on five year end-results and the recurrence rate for these procedures are about the same. The recurrence rate, as reported here, is 23 per cent for irradiation and 24 per cent for laryngectomy. The results reported in this paper show a hopeless prognosis for the treatment of a recurrence after laryngectomy. For a recurrence after laryngofissure or irradiation, the prognosis is not hopeless. In Table I, out of 10 recurrences following laryngofissure, only 4 received additional treatment and 3 of these patients survived five or more years. Of 19 recurrences following irradiation (Tables IV and V), 14 received additional treatment. Five of these patients were living free of disease five years after treatment. Obviously, from the above facts it would appear that where the indicated procedure is irradiation or laryngectomy, radiation treatment should be given the preference. If, after the irradiation, a recurrence develops, such a patient still has the opportunity of successful treatment by laryngectomy.

These criteria are suggested as the basis for the selection of a method of treatment of cancer of the larynx.

1. The presence or absence of cervical metastases.
2. The location and extent of the lesion as evidenced by its appearance on direct and indirect laryngoscopy and by its appearance on lateral and planigraphic roentgen studies.
3. The motility and mobility of the lesion.
4. The histopathologic character of the lesion.
5. The general physical condition and temperament of the patient.
6. The probability of recurrence and prognosis for further treatment. (Recurrence rates: laryngofissure, 17 per cent; irradiation, 23 per cent; laryngectomy, 24 per cent. Treatment prognosis: recurrence after laryngofissure and irradiation, good; recur-

rence after laryngectomy, questionable.)

Metastases play an important part in selecting the treatment. Fortunately, only a small group of the cases of intrinsic cancer of the larynx develop metastases. In an analysis of 156 cases of intrinsic laryngeal cancer, only 13, or 8 per cent, have metastases on admission and another 16, or 10 per cent, developed metastases later in the course of the disease.

From a study of Table VI, it is obvious that patients with metastases have a very poor prognosis. When metastasis was present on admission, 1 out of 13 (8 per cent) survived five years. This patient had the metastatic lymph node removed at the time of the laryngectomy. The 4 patients treated by irradiation died.[1]

TABLE VI

ANALYSIS OF TREATMENT OF CERVICAL METASTASES FROM CANCER OF LARYNX
(1930–1941 inclusive)

Treatment	Cases	Dead of Disease	Dead of Other Causes	No Evidence of Disease
Roentgen irradiation	22	21	—	1*
Roentgen irradiation plus radon	1	1	—	—
Surgery	1	—	—	1
Combination of surgery, roentgen irradiation, and/or radon	7	3	1	3

* Reticulum cell lymphosarcoma.

Prior to 1939 cervical metastases were treated exclusively by external irradiation. There were no survivals in this group. (Table VI). Since 1940 the treatment of cervical metastases in our clinic has been as follows: (1) For patients presenting metastases on admission, roentgen treatment is employed for treatment of the primary lesion in the larynx, and if possible, the metastases are incorporated in the same field. If not, an additional field is employed. Following the irradiation, either before the severe radiation epithelitis develops or after it has completely healed, the metastases are surgically exposed and radon is implanted or a neck dissection with or without implantation of radon is performed. (2) For metastases occurring after the primary lesion has been controlled, a neck dissection with or without implantation of radon is performed. External irradiation is never used in the treatment of metastases in this group.

The location and extent of disease are especially important to evaluate in early cancer of the vocal cord. All cases where the lesion is limited to the cord itself or even involving the opposite cord without subglottic extension are best treated by laryngofissure, either by the clipping or anterior commissure techniques. In our clinic, we feel that cord lesions which are infiltrating or involving the thyroid cartilage or growths that are subglottic are best treated by laryngectomy. It must be admitted that some of these can be successfully treated by irradiation. Cutler[5] prefers to treat these by his so-called "concentration method." Our decision in this group of cases is based on observations of late complications that are apt to occur. It is in this group that radiation sloughing and "radiation laryngectomies" are likely to happen. The cartilage and bone, either tracheal, thyroid or cricoid, when infiltrated by tumor become exposed as the tumor tissue regresses and sloughs. This exposed cartilage is readily infected, resulting in a chondritis and osteomyelitis with subsequent sloughing. This type of complication, we feel, should be avoided whenever possible. In this type of lesion we occasionally see a patient die of sudden hemorrhage. All cases where the lesion is too extensive for laryngofissure and the above contraindications are not present, we feel should be treated by irradiation.

When mobility of the laryngeal structure is impaired or these structures are fixed, it is usually an indication of rather advanced disease and deep infiltration. This is seldom encountered in the intrinsic group but is frequently observed in the extrinsic cases. In these cases laryngectomy is the procedure of choice.

TABLE VII

EVALUATION OF HISTOPATHOLOGIC GRADING AND METHOD OF TREATMENT OF SQUAMOUS CELL CARCINOMA
(1930–1937 inclusive)

Grade 1					Grade 2				
Total Determinate Cases	Five Year Survival without Disease		Dead of Disease		Total Determinate Cases	Five Year Survival without Disease		Dead of Disease	Recurrence Treated by Other Means
13	13	100%	0	Laryngofissure	25	20	80%	4	1
7	5	71%	1	Laryngectomy	22	14	64%	8	—
1	1		0	Irradiation	15	9	60%	6	—
		95%		Net Five Year Survival Rate			70%		

When impairment or even fixation of one vocal cord occurs, it does not necessarily mean involvement of cartilage. This may occur either in cases of partial or complete cord destruction or where there is infiltration into the submucous tissues. We do not feel that these these findings contraindicate irradiation. Impairment of cord motility is also observed where there is an inflammatory reaction coincident with the cancer. In these cases during irradiation the impairment diminishes or may completely disappear.

The histopathologic character of the lesion, we feel, is of great significance in the selection of a treatment method. Results of radiation treatment in cancer of the larynx have shown conclusively that squamous cell carcinoma is radiosensitive and radiocurable.[1,5] Much can be said about the inadequacy of Broders' classification for grading; nevertheless, in our experience at Temple University Hospital the grading of tumors has been most helpful.[2] To date Grade 3 tumors treated by roentgen irradiation have given the poorest results (Table VIII). Squamous cell carcinoma, Grade 3, in our opinion, should not be treated by

TABLE VIII

EVALUATION OF HISTOPATHOLOGIC GRADING AND METHOD OF TREATMENT OF SQUAMOUS CELL CARCINOMA
(1930–1937)

Grade 3						Grade 4			
Total Determinate Cases	Five Year Survival without Disease		Dead of Disease	Recurrence Treated by Other Means		Total Determinate Cases	Five Year Survival without Disease		Dead of Disease
17	11	65%	4	2	Laryngofissure	3	2	67%	1
27	12	44%	15	—	Laryngectomy	—	—		—
15	4	27%	10	—	Irradiation	3	2	67%	1
		46%			Net Five Year Survival Rate			67%	

irradiation, unless it is a very early lesion which is not suitable for laryngofissure, or other contraindications to surgery are present. Our experiences in recent years support this point of view. In squamous cell carcinoma, Grade 3, the results of laryngectomy and laryngofissure are superior to those of irradiation (Table VIII).

Squamous cell carcinoma, Grade 1, is not a radioresistant tumor.[1]

Up to 1940 three patients with a Grade 1 lesion were treated by irradiation. Two survived five years; one is living free of disease eight years after treatment and the other survived five years and was killed in a railroad accident. The third patient remained free of disease but died of Hodgkin's disease about one and a half years after treatment.

Squamous cell carcinoma, Grade 4, is radiosensitive and radiocurable.

SELECTION OF TREATMENT METHOD

The selection of the treatment method, surgery or irradiation, must not be made on a competitive basis but should be made for each patient after a thorough consideration of all factors above discussed. A perusal of recent literature reveals that most articles present results of one treatment modality, such as laryngofissure, laryngectomy or irradiation. *All three procedures have been shown to be effective in selected cases. There is no one method by which all cases of cancer of the larynx can or should be treated.*

At the Chevalier Jackson Bronchoscopic Clinic at Temple University Hospital, laryngofissure is employed in every case suitable for this procedure. If there is some contraindication to this surgical procedure or if the patient refuses this advice, then irradiation is advised. We agree with the proponents of irradiation that these cases would be most suitable for this treatment and the results might be equally as good as for laryngofissure. The fact remains that the operative procedure has an 80 to 85 per cent cure rate and we therefore feel it has definitely established itself and need not be discarded in favor of irradiation at this time. When the statistics in this type of case have become sufficiently large to be of significance, then the treatment by laryngofissure or by irradiation will deserve reevaluation.

The treatment modality can be safely selected on the basis of the following criteria and suggested treatment.

CRITERION	RECOMMENDED TREATMENT
1. *Metastases*	
a. Cervical metastases present	Irradiation to primary lesion Irradiation and/or surgery and/or radon
b. Cervical metastases absent	1. Laryngofissure 2. Laryngectomy 3. Irradiation
2. *Histopathology*	
a. Squamous cell carcinoma, Grade 1 and 2	1. Laryngofissure 2. Laryngectomy 3. Irradiation
b. Squamous cell carcinoma, Grade 3	1. Laryngofissure 2. Laryngectomy
c. Squamous cell carcinoma, Grade 4	1. Irradiation 2. In early cases limited to 3a, 3b, 3c, laryngofissure may be indicated
3. *Extent of Involvement*	
a. Growth limited to one cord not invading arytenoid or posterior commissure	Laryngofissure
b. Growth limited to anterior commissure and anterior third of each cord	1. Laryngofissure 2. Irradiation
c. Growth involving one cord ventricle	Laryngofissure
d. Subglottic extension	Laryngectomy
e. Growth involving anterior commissure, cord and base of epiglottis	Laryngectomy
f. Growth involving cord, aryepiglottic fold with limitation of motility	1. Irradiation 2. Laryngectomy
g. Growth involving posterior commissure, pyriform sinus, aryepiglottic fold and epiglottis, or party wall	1. Irradiation
4. *Motility and Mobility*	
a. Impaired motility of cord	1. Irradiation 2. Laryngectomy
b. Partial impairment of mobility of larynx	1. Laryngectomy 2. Irradiation
c. One side of larynx fixed or greatly impaired	Laryngectomy

CRITERION	RECOMMENDED TREATMENT
5. *General Factors*	
a. Presence of other disease contraindicating radical surgery	1. Irradiation 2. Laryngofissure
b. Temperament of patient—if patient cannot become adjusted to a laryngectomy	Irradiation

SUMMARY

The results of the treatment of recurrences following laryngofissure, laryngectomy, and irradiation are presented and discussed. Recurrence after laryngofissure may be successfully treated by irradiation or laryngectomy. Recurrences following irradiation can be successfully treated by a second course of irradiation or laryngectomy. In an occasional selected case a laryngofissure may be indicated. The operative procedure is negligibly affected by previous irradiation. At the present time, recurrences following laryngectomy offer a hopeless prognosis.

Treatment of cervical metastasis may be divided into treatment of metastases on admission, and treatment of metastases occurring after the primary lesion has been controlled. When metastases are present on admission, the treatment is by irradiation, directed at the primary growth and the metastases. In addition, radon is implanted into the metastases or a partial or complete neck dissection may be performed. If the metastasis occurs after the primary growth has been controlled, the treatment is by neck dissection with or without the implantation of radon.

The criteria for the selection of treatment are discussed. The method of selection of the treatment modality in a given case of cancer of the larynx is presented. It is further suggested that a careful study of the results of treatment of recurrences will help greatly in evaluating the complex problem of selecting the modality in the initial treatment of cancer of the larynx. The results of this analysis indicate that laryngofissure and roentgen irradiation have an important role in the treatment of cancer of the larynx. Laryngectomy must be reserved for the selected cases in which the above two procedures are contraindicated or have a poor prognosis, and also as an important procedure in the treatment of recurrence following laryngofissure and irradiation.

I wish to express my appreciation to Dr. A. E. Aegerter and to Dr. A. R. Peale of the Pathology Department, Temple University Hospital, for reviewing the histopathologic material reported in this study.

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DISCUSSION

DR. DOUGLAS QUICK, New York. Dr. Blady is dealing with a very trying and difficult group of cases—recurrent carcinoma of the larynx. I think he has a very versatile manner of approach and versatile mind in approaching it. I have just one thing to suggest. When one is charged with the responsibility of dealing with a growth that has already gotten out of hand there is little of basic responsibility for maintenance of tissues and maintenance of continuity of the airway. The first responsibility at that stage is the saving of life if possible. Consequently, if a destructive process is to be resorted to, or perhaps I should say, risked, I think it is better to use one that can be controlled rather than one that is apt to get somewhat out of control at times. In some of Dr. Blady's cases, therefore, it would seem to me perhaps safer to resort to the rather radical use of the cutting cautery of low intensity and then irradiating the fresh base rather than attempting to handle the entire situation by irradiation alone. If the growth can be controlled by such a combination of measures, plastic procedures will usually go a rather long way toward restoration of reasonable function.

DR. BLADY (closing). Dr. Quick, of course, suggests one of the correct procedures; that is, extensive fulguration or cautery removal of the tumor. In the neck it is not always possible to perform an extensive cautery removal of a recurrence such as would be indicated for a recurrence after laryngectomy. There are many vital structures in this region of the neck, and an extensive fulguration or cauterization could easily result in a fatality due to hemorrhage, mediastinitis or aspiration pneumonitis. These same complications may follow sloughing, which is a natural sequela of extensive fulguration.

In some of these cases we have considered doing a radical surgical excision with a resection of the sternum and placing the tracheotomy opening within the sternum itself. Such a procedure, although feasible, might not be well tolerated by the patient.

Dr. Leddy states that the cases of cancer of the larynx he sees are far advanced and inoperable and justifies the poor end results on this basis. At the Chevalier Jackson Bronchoscopic Clinic and the X-ray and Radium Therapy Department of Temple University Hospital we, too, see many of these far-advanced and inoperable cases. Some of the patients that we see have extensive ulcerated lesions, which have perforated through the skin. The fact that these lesions are inoperable does not mean that these patients should not be treated. Every patient should be given a chance, and we do not deny this chance to anyone even though in some cases this chance looks slim indeed. Naturally, there are not many salvages in this group of cases. In our end results we include all of the patients that we see, regardless of the state of the disease or the stage of operability. We treat every patient who comes to the clinic. Only those patients who are seen in consultation and are not treated by us are excluded from these statistics.

Many of our patients are in extremely poor nutritional state. It is necessary to have these patients hospitalized for supportive measures before the institution of treatment. They are given an adequate caloric, protein and carbohydrate intake along with adequate vitamin therapy and, if needed, blood transfusions and other intravenous medication. It is surprising how quickly these patients show improvement and can then be given the necessary treatment and can withstand the rigors of curative therapy, whether by surgery or by irradiation. Many of our patients, under this regimen, have gained weight in spite of the intensive radiation reaction on the skin and the mucous membranes, which follows after a cancer-lethal dose has been delivered to the tumor.

One of the discussors remarked that he was not in accord with such "dogmatic criteria" as were presented in this paper. It is unfortunate that in this age of progress we still find people relying on their infallible personal ability to judge what is the best treatment in a given case rather than to rely on criteria based on proved facts and end results.

During the past eight years we have carefully studied our patients. The relationship of various factors and end results of treatment by surgery and by irradiation were analyzed in an effort to determine whether any criteria could be established which would help in selecting the best treatment procedure in a case of cancer of the larynx. The criteria which are presented, we

feel, are pretty well founded on results obtained to date.

Now regarding the question of "placebo irradiation." I think that every patient, when he is first seen, should be given every opportunity of being cured. In other words, we should regard the treatment that is outlined as a curative procedure rather than as a "placebo". It is my opinion that "placebos" are something antiquated. They have no place in the present-day treatment of cancer of the larynx. We should in all cases, regardless of how hopeless the outlook may be, give that patient, if he so desires, a chance to be cured by treating him with the intent of curing. I could cite many instances where the unbelievable or miraculous result was obtained. Only recently we had the opportunity of seeing a patient who had extensive disease of the larynx with involvement of the laryngeal cartilage, a draining sinus in the skin and cervical metastasis. Because of this extensive disease and cervical metastasis, we did not feel that the patient should even be given the benefit of irradiation. Nevertheless, this was done. Later the metastasis was treated by neck dissection. For the past nine months the patient has been symptom free; clinically there has been no evidence of residual or recurrent disease, and he has been able to carry on his occupation.

Age likewise should be no deterrent in the treatment with intent to cure. Several years ago we treated a patient sixty-five years of age with the intention of primarily arresting the disease temporarily but not with the intention of curing, thinking that the amount of radiation to cure the lesion might be fatal to the patient. As a result, 2,500 roentgens, measured in air, were delivered to each side of the neck. A regression took place which lasted for about seven months. Again another course of treatment was given. Again there was regression. Finally, after about a year of this type of therapy, the recurrence was so extensive that nothing more could be done, and the patient died of the recurrent disease. In retrospect, I feel that an error of judgment was committed. This patient would have tolerated one course of intensive irradiation without much difficulty and might have been cured. Instead, it was necessary to give him several courses without giving him a chance of being cured. Since this experience, we treat all patients, regardless of age, with the intent to cure. We deliver a tumor dose that is cancericidal based on available scientific data.

I wish to thank Dr. Quick and the other participants for their interest and excellent discussion.

THE STANDARDIZATION OF ROENTGENOGRAPHIC TUBES AND HIGH VOLTAGE CABLES*

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SINCE the introduction of shockproof roentgenographic equipment several years ago, the roentgen-ray industry has been asked on a number of occasions to standardize the terminal design of its diagnostic tubes and high voltage cables so that the tubes and cables of one manufacturer might be freely interchangeable with those of another. The advantages of such standardization are evident. First, the maintenance and repair of roentgenographic apparatus would be greatly facilitated. Also, the production costs of roentgen-ray tubes and cables would be significantly lowered. And finally, the inventories of such extensive users of roentgenographic equipment as the Army, the Navy, the Veterans Administration, and the Public Health Service would be enormously reduced and their supply problems markedly simplified.

Until recently, the roentgen-ray industry has been somewhat reluctant to heed these requests, notwithstanding the advantages just cited. It has pointed out that if a standard terminal design were adopted, each manufacturer would be required to maintain a double inventory of tubes and cables for a period of several years to meet the service requirements of the roentgenographic equipment now in general use as well as the standard apparatus to be produced in the future. The industry also has indicated that the financial and engineering burdens placed on each manufacturer when converting to a new terminal construction are not insignificant.

The validity of the foregoing objections to a standardized terminal design cannot be disputed. However, these objections do not seem insurmountable nor do they appear to offset the advantages that would accrue if the industry were to embark on a standardization program. Fortunately, the industry itself is now apparently inclined to discount the significance of its objections for within the past year it has decided to undertake the development of a standard terminal design which will permit the free interchange of the tubes and cables of one manufacturer with those of another. At the present time, the engineering staffs of the several manufacturers are collectively preparing plans for the new terminal and within the coming year the final design should be completed. The industry deserves the commendation of the profession for this far-sighted decision.

When the design of the new terminal was first undertaken, the industry was somewhat uncertain regarding the kilovoltage which the terminal should withstand. In recent years, several roentgenologists have expressed a desire for voltages in excess of the 100 kv. (peak) now generally available in roentgenographic equipment and the industry, feeling that this expression of opinion indicated a trend toward the routine use of higher voltages in diagnostic roentgenology, wished to have reliable data by which the upper limit of this trend might be estimated. It was stated that without such information the terminal design finally agreed upon might soon be obsolete.

Recognizing this problem, the Radiology Section of the Tuberculosis Control Division volunteered to investigate quantitatively in its laboratory the effect of roentgen tube potentials on the roentgenographic process and to make the resulting information available to the industry through the X-ray Technical Committee of the Na-

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tional Electric Manufacturers Association. The industry welcomed this gesture and late in 1945 the investigation was begun.

The study undertaken by the Radiology Section was divided into three phases: (a) an investigation of the effect of roentgen tube potentials on the clarity with which roentgenographic images may be visualized, (b) an investigation of the effect of roentgen tube potentials on the efficiency with which a roentgenographic machine operates, and (c) an investigation of the effect of roentgen tube potentials on the radiation dosage received by an individual during roentgenoscopy. It was thought that the quantitative data derived from such a comprehensive study would provide a reasonably satisfactory solution to the problem which confronted the industry.

A complete report of these investigations has been published.[1] Accordingly only a summary analysis will be given at the present time.

Roentgen tube potentials influence the clarity with which a roentgenographic image is recorded by affecting its contrast. As anticipated, it was found that roentgenographic contrast increases as tube potentials decrease, the effect being minimal for the images cast by soft tissues but quite considerable for the images of calcified structures. It appeared that with one possible exception the lowest roentgen tube voltage consistent with a reasonable exposure time will produce roentgenograms of optimum quality and that under almost all circumstances this voltage will be well below 100 kv. (peak). The one exception to this general rule is chest roentgenography. Here the use of tube potentials in excess of 100 kv. (peak) and the use of a grid permit the production of roentgenograms in which the shadows cast by the ribs do not obscure the images of the pulmonary structures.

The effect of roentgen tube potentials on the efficiency with which a roentgenographic machine operates is of particular importance in photofluorography for under this condition the roentgen tube is frequently operated near its heat liberating capacity. It was found that the efficiency of roentgen-ray production varies almost proportionally with the voltage applied to the roentgen tube under conditions simulating those existing in photofluorography. That is, at 125 kv. (peak) 25 per cent more light is produced by the photofluorographic screen for a given amount of electrical energy consumed by the roentgen tube than that occurring at 100 kv. (peak). Although this gain in efficiency is not spectacular, it nevertheless is sufficient to demand careful consideration.

In regard to the effect of roentgen tube potentials on the radiation dosage received by the skin of a patient during roentgenoscopy, it was found that for a given screen brightness the dosage decreases slowly as the roentgen tube potential is increased until it reaches a minimum at a voltage of approximately 120 kv. (peak). Thereafter the dosage increases slightly. The exact voltage at which minimum dosage occurs depends on the size of the field under examination, the thickness of the anatomical structure and other similar factors. However, this voltage does not deviate significantly from 120 kv. (peak) through a wide range of conditions.

After careful consideration of the foregoing data the roentgen-ray industry decided that it should design its standard tube and cable terminal to withstand potentials sufficient to permit the operation of diagnostic roentgen tubes at 125 kv. (peak). Since these tubes are customarily operated under conditions in which ground potential is midway between the anode and cathode potentials, the terminal therefore will have a nominal rating of 62.5 kv. (peak) (i.e., ½ of 125 kv. (peak)). In making this choice, the industry pointed out that it believes that most diagnostic roentgenology will continue to be performed at voltages considerably below 100 kv. (peak). However, since there likely will be occasions when many roentgenologists may wish to work

[1] Morgan, R. H. Roentgen tube potentials in diagnostic roentgenology. AM. J. ROENTGENOL. & RAD. THERAPY, August, 1947, *58*, 211–221.

at higher potentials, the industry thought it wise to provide the standard terminal with the highest possible rating within the limits of economic expendiency. The new terminal will permit the roentgenologist to work with voltages at which his patients will be subjected to a minimum radiation dosage during roentgenoscopy, with voltages at which his photofluorographic equipment may be operated at a substantially greater efficiency than has heretofore been possible and with voltages at which many new and improved techniques, particularly in the field of chest roentgenography, may be developed. Furthermore, the voltages provided by the new terminal will require no significant change in the design of present day roentgen generators. Thus, generators equipped with the standard terminal will not differ significantly in size or cost from those now available.

It has been decided that the cathode and anode terminals will be of identical design. Furthermore, the terminals used in roentgen-ray tubes will be identical to those used in roentgen generators. It therefore will be possible for service organizations to make all replacements of defective high voltage cables with a single cable type in the future. Cable inventories will thereby be reduced to an absolute minimum.

At the present time plans for the size and shape of the terminal are being prepared. When these are completed the terminal will be ready for general adoption by the industry. It is not anticipated that when this time comes there will be a simultaneous industry-wide conversion to the new terminal. The relative inflexibility of production schedules and the problems of post-war reconversion preclude such a program. Instead it is planned that each manufacturer will adopt the new terminal at a time that seems most expedient to do so. Undoubtedly some manufacturers will convert to the new terminal immediately. Others, however, will likely do so only after several months have elapsed.

It is gratifying to observe the progressive attitude taken by the roentgen-ray industry in this development. Indeed there is every reason to believe that other programs of standardization will be undertaken before long. It is generally recognized, for example, that much would be gained by standardizing such items as valve tubes and their terminals and the mounting devices of roentgen-ray tubes. Let us hope that the industry will continue its fine work until the needless multiplicity of designs that now exist in many pieces of roentgenographic equipment is completely eliminated.

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DISCUSSION

DR. PAUL C. HODGES, Chicago, Ill. The advantages of complete standardization of cables, valve tubes and roentgen tubes are so obvious that they need no argument. In fact, the only objection that can be raised to standardization is the contention that it will be costly and temporarily inconvenient. But the contention is unsound and, as a matter of fact, it is lack of standardization that is costly and wasteful and the waste hurts us as individuals even though it is government money that is being spent or money from our own gross income which can be deducted from our income tax as an expense.

We radiologists could, if we would, apply the pressure necessary to assure standardization but the ones who will probably actually do it are the government agencies that have to buy this material in such large quantities. However if it is done, we radiologists will benefit when standardization is accomplished.

DR. LAURISTON S. TAYLOR, Washington, D. C. As a person very closely associated with this whole problem of standardization, I certainly want to congratulate Dr. Morgan, Dr. Hodges and their coworkers for their energy in having brought about this very desirable situation in the standardization of roentgen tubes and cables. That subject has been discussed by various groups for almost as long as cables have been in use.

Any problem of standardization is difficult. Each manufacturer will start out to produce a device which according to his manufacturing problems appears to him to be the most economical, to have the best sale value and to put

him in a proper competitive position on the market. That is, of course, very proper.

It is necessary, however, as things come into general use, to make a real attempt to avoid a large multiplicity of parts. This is particularly true and particularly important in any portion of the roentgen equipment which is subject to wear or which is subject to complete usage.

At the start of any standardization program, in a commercial standardization program, there are naturally going to be certain costs to the manufacturer above his ordinary manufacturing program. Don't anybody be deceived. The user will pay those costs. On the other hand, if a user stays a user long enough, he will surely receive the benefit of ultimately lower costs which will in all probability wipe out the higher initial costs.

It was mentioned that the standardization of cables would simplify servicing questions, particularly in the Army and Navy and Veterans Bureau. There is no question about that, and the government is attempting to standardize numerous other items in order to simplify what is at the present time a tremendously complicated government procurement program.

There is another person who will benefit very much by this program and that is the small user. There are a great many radiologists in isolated places. They may have a piece of equipment that is supplied by a company who doesn't have a service man to go five hundred miles for his particular equipment. If something goes wrong and he is out of commission for a few days the patients suffer and he suffers. If it is possible for him to go to anybody's stock and get a replacement part, such as a cable, naturally his efficiency of operation is going to be greatly improved.

Dr. Morgan mentioned the question of standardization of other items. I think, myself, that two of the most important items to be standardized in the future are roentgen tubes and valve rectifiers. Those two points were mentioned. At the present time, one frequently has great difficulty in getting a replacement tube when he wants it and where he wants it.

Standardization in this field ought to be no more difficult ultimately than the standardization of an electric light bulb. You can imagine our difficulties if we had half a dozen different types of sockets or the states passed their own rules as to what kind of a socket one would have. We have almost that situation now in the x-ray field.

There is one other point which isn't exactly in the way of standardization of material, but nevertheless which does in my opinion offer a field for unification, at least. That is in the descriptive ratings of roentgen-ray equipment. At the present time, roentgen-ray equipment carries a name plate. It may say as much as 220 volts, 60 cycles on a plate. It is a very rare thing indeed for it to say anything more. It is perfestly feasible and it is highly desirable, in my opinion, that roentgen-ray transformers, tubes, cables, glass, all sorts of items of that sort be properly labeled with standardized labels in such a way that anybody at any time can tell exactly what he has on his hands.

The work can be carried further, not exactly into standardization of a specific item but in standardization of methods of ratings. For example, at the present time, when one wishes to compare roentgen films put out by two manufacturers, he is very much at the mercy of the manufacturer as to how he can compare the film of one manufacturer with that of another.

I don't know that there are any standard, recognized schemes at the present time for describing the necessary qualities of roentgen films. Similarly, for roentgen fluorescent screens, intensifying screens, and quite a number of other items. I think it would be inadvisable, on the other hand, to attempt standardization of such things as transformers, timers, shutters, and so on. Those questions have been brought up but I think that their standardization, as we know it at the present time, is probably undesirable.

One must always bear in mind that standardization, if done carelessly, will unquestionably stifle development. The important thing is to have the manufacturers operate through an organization in which they have membership so that they can get together and discuss these problems so that the radiological societies can approach the organization and present their problems. Such an organization does exist in the National Electric Manufacturers Association and I think Dr. Morgan and his people have done an excellent job in presenting some of the radiological problems to this group and arousing the interest and activity of the manufacturers.

Dr. Morgan (closing). There is just one thing that I would like to say in closing. The

roentgen-ray industry is planning a meeting for the final freezing of its designs later this month. and I think that now would be a good time to extend an invitation to many of you, as radiologists, to write to me and express your opinions as to your particular likes and dislikes regarding various designs with which you have worked in the past.

Although as a radiologist, I have tried to visualize as many of the problems as possible that you are facing day in and day out and have tried to include in the recommendations the things that you would naturally think of, it is unlikely that all of the ideas that should be incorporated in the standard cable design have been included.

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COMPARATIVE VALUE OF DEEP AND SUPERVOLTAGE ROENTGEN THERAPY*

STATISTICAL ANALYSIS OF FIVE YEAR RESULTS IN SELECTED GROUPS

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FIFTEEN years have now elapsed since the introduction of supervoltage roentgen therapy in the treatment of cancer and therefore it may appear advisable to try to estimate, on the basis of all available data, whether or not such a method has justified itself sufficiently to become part of our daily radiologic practice.

The physical investigations[4,6,9,10,13] demonstrated that supervoltage roentgen therapy has a definite advantage over deep roentgen therapy for at least three reasons: (1) it permits the administration of a certain physical dose to cancer with less effect on the skin; (2) because of the greater depth dose and the lesser attenuation of the beam it makes possible a more homogeneous irradiation, especially of large volumes of tissue, and (3) it permits a simplification of the technique of irradiation by reducing the number of portals necessary for the purpose of crossfiring.

Early publications seemed to indicate that there is an advantage also from the clinical point of view.[7,9,15] It appeared that localized deep-seated cancers were being treated more efficiently with supervoltage roentgen therapy than with deep roentgen therapy. The general reactions were less, the patients recovered more rapidly and the percentage of immediate results had been definitely raised. However, as time went on, the analysis of the late results revealed a somewhat different picture. Some investigators found that the good initial response was followed not infrequently by permanent cures, but others were disappointed to see that this objective had not been fulfilled.

REVIEW OF THE LITERATURE

Schmitz and Sheehan,[11] in 1941, published the five year survivals in a group of 26 cases of carcinoma of the cervix uteri treated by supervoltage roentgen therapy at Mercy Hospital, Chicago, and were able to show that 46.1 per cent of the patients were cured. In a later report from the same institution[12] the observation was extended to 72 cases, of which 37.5 per cent remained well after five years. This represented a very distinct improvement in favor of supervoltage roentgen therapy as compared to the former results obtained with deep roentgen therapy. A similar improvement was described by Kamperman[5] in most gynecologic cancers.

Colby and Schulz[1] in 1943 reported on a total of 139 cases of neoplasms of the bladder treated by supervoltage roentgen therapy over a period of five years at the Collis P. Huntington Memorial Hospital and Massachusetts General Hospital. In these cases supervoltage roentgen therapy was given as an accessory method to other standard procedures. By calculating from the time of the onset of the disease, 40 per cent of the cases were alive after four years as compared to 20 per cent prior to the institution of supervoltage roentgen therapy, and 15 per cent of untreated cases. Later, Holmes and Schulz[3] added another 57 cases of vesical carcinoma, all inoperable, in which supervoltage roentgen therapy constituted the most important part of the treatment, although radium implantation and fulguration were also used. In these latter cases the five year survival curve has fallen short of the expectation,

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amounting to only about 10 per cent. Phillips[9] reported on several groups of cases treated at St. Bartholomew's Hospital, London, and he noted definite improvement in carcinoma of the cervix, carcinoma of the larynx and especially carcinoma of the rectum.

On the other hand, Watson and Urban[14] found that supervoltage roentgen therapy produced only a palliative effect of very short duration in a series of 63 cases of intrathoracic cancer treated at Memorial Hospital, New York. Hocker and Guttman[2] have likewise given a discouraging account of 315 cases of carcinoma of various locations which were treated from August, 1939, to February, 1943 at the same institution. They state, however, that in nearly half of the cases, the disease was so advanced that palliation was all that could be expected from the beginning.

Very recently, Holmes and Schulz[3] in an excellent article have reviewed 1,835 cases of malignant neoplasms of all locations treated with supervoltage roentgen therapy at the Collis P. Huntington Memorial Hospital from 1937 through 1941 and at the Massachusetts General Hospital from 1940 through 1944. They state that in addition to the cutaneous advantage and the good immediate palliation a slight but definite increase in life expectancy was noted when the cases were properly chosen. Although more information is necessary before final conclusions can be drawn, they feel that the method should be encouraged in selected cases of carcinoma of the cervix, carcinoma of the bladder, carcinoma of the lung, embryoma of the testicle, carcinoma of the tonsil, localized lymphoma, Ewing's tumor and carcinoma of the rectum.

Because of this paucity of material, it may not be out of place to bring up to date the five year results in selected groups of cancer as obtained at Harper Hospital, Detroit, where supervoltage roentgen therapy has been employed routinely since 1933. The report is to some extent a continuation of a similar one published in 1940[8] and also embodies most of the gynecologic cases referred to by Kamperman.[5]

MATERIAL

The present study is based on a series of 1,888 cases treated from 1923 to 1940 inclusive, of which 1,038 received deep roentgen therapy and 850 supervoltage roentgen therapy. To obtain better comparable data the series is divided into lots of five years. The first lot includes the cases treated from 1923 to 1927, the second lot from 1928 to 1932, the third lot from 1933 to 1937 and the fourth lot from 1938 to 1940. In the first two lots deep roentgen therapy was used. The effect of the technical improvement of the irradiation with the passage of time is evidenced in the slight increase of the results of the second lot as compared to the first in practically all groups. In the third lot from one-third to one-half of the cases were treated by deep roentgen therapy and the remainder by supervoltage roentgen therapy. In the fourth lot supervoltage roentgen therapy was used almost exclusively.

In view of the fact that an over-all comparison is aimed at, no attempt was made to eliminate any cases. During the early days of supervoltage roentgen therapy, for example, many cases which proved refractory to deep roentgen therapy were subsequently treated with supervoltage roentgen therapy and, as is now known, no worthwhile improvements in the results may be expected in such instances. Yet, all these cases were included in the supervoltage roentgen therapy group. Likewise, radium-fast cases, especially of gynecologic cancer, repeatedly treated afterward with deep or supervoltage roentgen therapy are included in their respective groups. Even if the malignancy had reached such an advanced stage of development that irradiation could serve temporary palliation at best, or if the contemplated treatment for some reason could not be carried to conclusion, the case was not omitted. In this manner the figures obtained represent absolute values.

In estimating the permanency of the results, the five year survivals were taken into consideration. The untraced cases showed a variation of from 0 to 5 per cent

for the different years. They were all temporarily included among the dead so that by the time a 100 per cent follow-up is reached, the figures for certain years will change slightly for the better.

The factors of irradiation have remained in the main the same, except for improvements in the technique of procedure. The deep roentgen therapy was carried out with 200 kv. (peak), 1.5 mm. Cu, 1 mm. Al, half-value layer 1.9 mm. Cu, and an intensity of 20 r per minute at 50 cm. skin target distance. The factors of supervoltage roentgen therapy were: 500 kv. (constant), 7 mm. Cu, 3 mm. Al, 3 mm. celluloid, half-value layer 9 mm. Cu, and an intensity of 20 r per minute at 60 cm. skin target distance. When the technique of irradiation was changed, a more or less similar method was used for both types of roentgen rays.

SELECTED GROUPS OF CASES

Since physical measurements show that the greater value of supervoltage roentgen therapy in relation to deep roentgen therapy lies chiefly in a better distribution of the radiation within a given volume of tissue, it was thought advisable to select for the purpose of comparison lesions of such locations of the body that bring this advantage to the forefront in a maximum degree. Two good examples in this respect are the neck and the pelvis. The former is a slender part of the body with a transverse diameter of only 8 to 16 cm. so that a relatively large tissue dose can easily be administered with both types of roentgen rays. The latter constitutes a part of much wider dimensions and therefore the administration of a certain tumor dose necessitates crossfiring through a number of portals. On theoretical and physical grounds supervoltage roentgen therapy, because of a greater depth dose, would seem to possess here a definite advantage. The lesions chosen and their relative indidences are given in Table 1.

(1) *Carcinoma of the Tongue.* This lesion is included since the prognosis in the vast majority of the cases depends upon the extension to the lymph nodes of the neck and since the primary focus itself is located in a terrain so difficult to irradiate. In lot 1 the percentage of regional metastases to the neck at the time of the institution of treatment amounted to 88 per cent, in lot 2 to 70 per cent, in lot 3 to 68 per cent and in lot 4 to 76 per cent. The treatment consisted in protracted fractionated irradiation of the oral cavity and neck with the addition of interstitial radium, cautery or surgical excision of the primary focus. The results indicate no difference between deep roentgen therapy and supervoltage roentgen therapy, except in lot 3 where there is a slight improvement in favor of supervoltage roentgen therapy (Table II).

TABLE I

SELECTED GROUPS OF CARCINOMA OF VARIOUS LOCATIONS TREATED FROM 1923 TO 1940

Carcinoma of	Total Cases: Deep Roentgen Therapy	Total Cases: Supervoltage Roentgen Therapy	Total Cases
Tongue	69	47	116
Larynx	44	55	99
Thyroid	36	42	78
Cervix uteri	512	367	879
Fundus uteri	66	95	161
Ovary	140	102	242
Rectum	98	55	153
Bladder	73	87	160
TOTAL	1,038	850	1,888

(2) *Carcinoma of the Larynx.* It must be stated that at the beginning of the series only the inoperable cases of carcinoma of the larynx were referred for radiation therapy. Therefore the treatment consisted of fractionated protracted irradiation, without any other accessory method. In a few instances emergency tracheotomy had to be performed during the course of the irradiation. In later years, a combination of surgery and radiation therapy was used more often. This change of procedure

TABLE II

FIVE YEAR SURVIVALS IN CARCINOMA OF TONGUE

Years	Deep Roentgen Therapy			Years	Deep Roentgen Therapy			Supervoltage Roentgen Therapy		
	Cases	Well	Per Cent		Cases	Well	Per Cent	Cases	Well	Per Cent
1923	5	—	—	1933	6	1	17	—	—	—
1924	5	—	—	1934	—	—	—	2	1	50
1925	8	—	—	1935	—	—	—	5	1	20
1926	5	—	—	1936	4	—	—	6	2	33
1927	9	—	—	1937	—	—	—	3	1	33
TOTAL	32	—	—		10	1	10	16	5	31
1928	2	—	—	1938	2	—	—	4	1	25
1929	6	1	17	1939	—	—	—	12	—	—
1930	6	1	17	1940	—	—	—	15	3	20
1931	7	1	14							
1932	5	1	20							
TOTAL	26	4	15		2	—	—	31	4	13

reflects to a certain extent on the results obtained, but, even so, it appears that the introduction of supervoltage roentgen therapy has produced some improvement (Table III).

(3) *Carcinoma of the Thyroid.* The results in carcinoma of the thyroid have remained practically the same throughout the entire series. The five year survivals amounted to about 40 per cent irrespective of whether the irradiation was carried out with deep or supervoltage roentgen rays (Table IV). A combination of surgery and radiation therapy was used extensively whenever possible.

(4) *Carcinoma of the Cervix Uteri.* In this

TABLE III

FIVE YEAR SURVIVALS IN CARCINOMA OF LARYNX

Years	Deep Roentgen Therapy			Years	Deep Roentgen Therapy			Supervoltage Roentgen Therapy		
	Cases	Well	Per Cent		Cases	Well	Per Cent	Cases	Well	Per Cent
1923	4	—	—	1933	—	—	—	3	—	—
1924	3	1	33	1934	—	—	—	10	2	20
1925	2	—	—	1935	—	—	—	10	2	20
1926	3	—	—	1936	5	—	—	1	—	—
1927	3	—	—	1937	3	—	—	2	—	—
TOTAL	15	1	7		8	—	—	26	4	15
1928	4	—	—	1938	—	—	—	7	4	57
1929	2	—	—	1939	—	—	—	14	4	29
1930	4	—	—	1940	—	—	—	8	2	25
1931	6	—	—							
1932	5	—	—							
TOTAL	21	—	—		—	—	—	29	10	30

TABLE IV

FIVE YEAR SURVIVALS IN CARCINOMA OF THYROID

Years	Deep Roentgen Therapy			Years	Deep Roentgen Therapy			Supervoltage Roentgen Therapy		
	Cases	Well	Per Cent		Cases	Well	Per Cent	Cases	Well	Per Cent
1923	4	2	50	1933	3	1	33	3	2	66
1924	3	1	33	1934	—	—	—	2	1	50
1925	5	2	40	1935	—	—	—	6	3	50
1926	2	1	50	1936	2	—	—	2	—	—
1927	4	2	50	1937	—	—	—	3	1	33
TOTAL	18	8	44		5	1	20	16	7	44
1928	1	1	100	1938	—	—	—	12	4	33
1929	—	—	—	1939	—	—	—	7	3	43
1930	4	2	50	1940	—	—	—	7	3	43
1931	3	1	33							
1932	5	1	20							
TOTAL	13	5	38		—	—	—	26	10	40

group, the method of treatment was changed several times. The cases of lot 1 were treated by hysterectomy and postoperative roentgen therapy when found operable and by intracavitary radium and deep roentgen therapy when diagnosed as inoperable. Since 1928 the operation, except in rare instances, has been completely abandoned and all cases subjected to intracavitary radium and external roentgen therapy. The main method remained the intracavitary radium, the dose being raised to the uppermost limit of tolerance. Roentgen therapy was used to make up for the deficiency of the dose, especially toward the periphery of the pelvis. The rationale of

TABLE V

FIVE YEAR SURVIVALS IN CARCINOMA OF CERVIX UTERI

Years	Deep Roentgen Therapy			Years	Deep Roentgen Therapy			Supervoltage Roentgen Therapy		
	Cases	Well	Per Cent		Cases	Well	Per Cent	Cases	Well	Per Cent
1923	58	9	16	1933	28	6	22	22	11	50
1924	49	8	16	1934	26	6	23	31	16	52
1925	40	8	20	1935	26	5	19	35	12	34
1926	41	3	7	1936	12	1	8	51	16	31
1927	38	5	13	1937	—	—	—	49	22	45
TOTAL	226	33	15		92	18	20	188	77	40
1928	45	10	22	1938	—	—	—	54	14	26
1929	48	10	21	1939	—	—	—	56	21	38
1930	28	6	22	1940	—	—	—	69	29	40
1931	37	7	19							
1932	36	8	22							
TOTAL	194	41	21		—	—	—	179	64	36

TABLE VI

FIVE YEAR SURVIVALS IN CARCINOMA OF FUNDUS UTERI

Years	Deep Roentgen Therapy			Years	Deep Roentgen Therapy			Supervoltage Roentgen Therapy		
	Cases	Well	Per Cent		Cases	Well	Per Cent	Cases	Well	Per Cent
1923	—	—	—	1933	4	1	25	2	1	50
1924	2	1	50	1934	3	—	—	3	3	100
1925	3	1	33	1935	3	2	66	9	3	33
1926	7	2	29	1936	2	1	50	9	6	66
1927	6	2	33	1937	1	—	—	12	6	50
TOTAL	18	6	33		13	4	30	35	19	50
1928	1	—	—	1938	—	—	—	20	10	50
1929	7	2	29	1939	—	—	—	20	9	45
1930	4	3	75	1940	—	—	—	20	10	50
1931	11	5	45							
1932	12	5	42							
TOTAL	35	15	43		—	—	—	60	29	48

this procedure was not modified by introducing supervoltage roentgen therapy. Thus the only difference in lots 2, 3 and 4 is the fact that the deep roentgen therapy was gradually replaced by supervoltage roentgen therapy. As shown in Table v, the five year survivals with deep roentgen therapy in lots 2 and 3 amounted to about 20 per cent, whereas with supervoltage roentgen therapy in lots 3 and 4 they were practically doubled.

(5) *Carcinoma of the Fundus Uteri.* In this group, a combination of hysterectomy and irradiation was used in the operable cases throughout the series. In lot 1 hysterectomy was carried out first and ir-

TABLE VII

FIVE YEAR SURVIVALS IN CARCINOMA OF OVARY

Years	Deep Roentgen Therapy			Years	Deep Roentgen Therapy			Supervoltage Roentgen Therapy		
	Cases	Well	Per Cent		Cases	Well	Per Cent	Cases	Well	Per Cent
1923	4	—	—	1933	15	2	13	11	2	18
1924	11	3	27	1934	10	1	10	7	2	28
1925	9	2	22	1935	9	1	11	7	—	—
1926	7	—	—	1936	1	1	100	11	2	18
1927	10	2	20	1937	1	1	100	16	6	38
TOTAL	41	7	17		* 36	6	17	52	12	23
1928	14	3	21	1938	—	—	—	25	6	24
1929	13	1	8	1939	—	—	—	13	6	46
1930	11	4	36	1940	—	—	—	12	4	33
1931	12	1	8							
1932	13	2	15							
TOTAL	63	11	17		—	—	—	50	16	32

TABLE VIII

FIVE YEAR SURVIVALS IN CARCINOMA OF RECTUM

Years	Deep Roentgen Therapy			Years	Deep Roentgen Therapy			Supervoltage Roentgen Therapy		
	Cases	Well	Per Cent		Cases	Well	Per Cent	Cases	Well	Per Cent
1923	11	1	9	1933	6	—	—	4	2	50
1924	10	1	10	1934	5	—	—	4	1	25
1925	8	1	12	1935	2	1	1	8	3	37
1926	2	—	—	1936	4	—	—	8	2	25
1927	7	1	14	1937	4	1	25	3	1	33
TOTAL	38	4	11		21	2	10	27	9	33
1928	9	—	—	1938	—	—	—	8	2	25
1929	7	—	—	1939	—	—	—	10	1	10
1930	7	1	14	1940	—	—	—	10	2	20
1931	9	1	11							
1932	7	1	14							
TOTAL	39	3	8		—	—	—	28	5	18

radiation applied in the form of deep roentgen therapy postoperatively. Since 1928, however, a course of intracavitary radium and external roentgen therapy has been undertaken first and the hysterectomy performed six weeks later. A second course of roentgen therapy was then given within two or three weeks after the hysterectomy. In the inoperable cases, a combination of intracavitary radium and external roentgen therapy has been used from the beginning. In lots 3 and 4 deep roentgen therapy was gradually replaced by supervoltage roentgen therapy for all cases. As is seen in Table VI this resulted in an increase of the five year survivals

TABLE IX

FIVE YEAR SURVIVALS IN CARCINOMA OF BLADDER

Years	Deep Roentgen Therapy			Years	Deep Roentgen Therapy			Supervoltage Roentgen Therapy		
	Cases	Well	Per Cent		Cases	Well	Per Cent	Cases	Well	Per Cent
1923	5	1	20	1933	4	1	25	2	1	50
1924	9	2	22	1934	2	—	—	5	1	20
1925	5	—	—	1935	2	1	50	4	1	25
1926	8	1	12	1936	1	—	—	10	2	20
1927	5	1	20	1937	7	1	14	12	3	25
TOTAL	32	5	16		16	3	19	33	8	24
1928	5	1	20	1938	—	—	—	27	8	30
1929	5	1	20	1939	—	—	—	8	1	12
1930	7	2	29	1940	—	—	—	19	5	26
1931	4	1	25							
1932	4	1	25							
TOTAL	25	6	24		—	—	—	54	14	26

from 40 per cent to about 50 per cent for the total group. The fact that more than half of the carcinomas of the fundus uteri are in the operable stage explains the relatively high percentage of the five year survivals with deep roentgen therapy and the lesser increase as compared to the cervix uteri when changing to supervoltage roentgen therapy.

(6) *Carcinoma of the Ovary.* The generally accepted method of combining surgery with roentgen therapy has been used in carcinoma of the ovary throughout the series. It is quite remarkable that with deep roentgen therapy the five year survivals in lots 1, 2 and 3 as shown in Table VII were uniformly 17 per cent. The introduction of supervoltage roentgen therapy first appeared to barely change the situation but in lot 4 the five year survivals rose to 32 per cent.

(7) *Carcinoma of the Rectum.* The cases of carcinoma of the rectum referred for radiation therapy were invariably of the inoperable or recurrent type. In a limited number a combination of intracavitary radium, or cautery and external roentgen therapy was used but the vast majority of them were treated by roentgen therapy alone. With deep roentgen rays the five year survivals, as is seen in Table VIII, amounted to about 10 per cent; with supervoltage roentgen rays to from 18 to 33 per cent.

(8) *Carcinoma of the Bladder.* A slight increase in the results was obtained also in carcinoma of the bladder. Table IX shows that for the deep roentgen therapy group the five year survivals represented about 20 per cent, whereas for the supervoltage roentgen therapy group they rose to 25 per cent.

SUMMARY AND CONCLUSION

In summarizing these results it appears that the assumptions based on theoretical considerations and physical measurements are now being substantiated by long range clinical observations. There can be no doubt about the fact that supervoltage roentgen therapy leads to considerably less damage to the skin than deep roentgen therapy. This may not be of great importance if life is prolonged only for a short while but when a permanent result can be secured in an increasing number of cases it is desirable that the skin be saved as much as possible.

As concerns the therapeutic efficiency on the tumor the only difference between deep roentgen therapy and supervoltage roentgen therapy is that the latter permits a better irradiation. There is no direct quality dependence in the sense that certain malignant neoplasms that fail to respond to deep roentgen therapy could be destroyed by supervoltage roentgen therapy. Therefore, no attempt should be made to replace well established methods, as for example association of surgery and roentgen therapy or a combination of radium and roentgen therapy by the sole use of supervoltage roentgen therapy expecting to improve the final results. Even in the inoperable cases, some accessory therapeutic method may become necessary after supervoltage roentgen therapy has helped create a more favorable situation. In this manner the role of supervoltage roentgen therapy runs parallel to that of deep roentgen therapy. However, by making possible a more efficient treatment in the selected case it will lead, especially in the presence of localized tumors which are seated in large volumes of tissue, to a definite increase in the final results.

The conclusion may be drawn, therefore, from a review of the literature and the data presented in this study, that supervoltage roentgen therapy is of noteworthy value in properly selected cases. It constitutes a desirable addition to our future radiotherapeutic armamentarium.

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DISCUSSION

DR. U. V. PORTMANN, Cleveland, Ohio. Dr. Leucutia has presented an interesting comparison of the results he has obtained with deep and supervoltage roentgen therapy. He is well qualified to do so after fifteen years of experience and being meticulous in the technique of administration and careful in clinical judgment and observation. His conclusions are properly conservative.

His presentation supports contentions that any improvement of supervoltage over deep roentgen therapy must be due to more homogeneous radiation and relatively greater depth dose because of more forward and less back scattered radiation with increasing voltages and filtration. In other words, the improvement must be physical and quantitative rather than biological or qualitative. This has been manifest since deep roentgen therapy superseded lower voltage roentgen treatment.

It has been the experience of Dr. Leucutia and others employing supervoltage roentgen therapy that a high proportion of cases so treated are in advanced stages of disease. The results in such cases, of course, would be disappointing and should not be compared with the results with other methods of treatment for cases with less extensive involvement. In judging the results it is necessary to take two factors into consideration. First, in radiation therapy we will always be confronted with biological factors influencing variations in radiosensitivity of tumors and, in addition, relative differences in radiosensitivity between neoplastic and normal tissues. Second, the fact that neoplastic cells may migrate from primary tumors to remote parts of the body, and though the primary tumor may be eliminated by irradiation, this will not affect metastases outside the area treated. Therefore, it is folly to expect to cure all patients with either radioresistant or radiosensitive tumors in any location when metastases are present or widely distributed, no matter what quality of roentgen rays may be available.

Dr. Leucutia has presented three logical advantages of supervoltage over deep roentgen therapy. These are based on purely physical and

technical factors. These advantages and his improved results further support the thesis that the effects of radiation on tissues are quantitative rather than qualitative. Also, he has properly stated that "supervoltage roentgen therapy is of noteworthy value" and cannot supplant but must supplement other methods such as radium therapy and surgery for the treatment of malignant diseases.

The most important factor governing curability of malignant tumors in any location will always be the anatomical extent of involvement at the time treatment is instituted. It is to be hoped that Dr. Leucutia and others will some time compare the results of deep and supervoltage roentgen therapy in series of cases classified or grouped on such a basis rather than only according to organs primarily affected.

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THE EFFECT OF ROENTGEN RAYS ON THE IN VITRO MOTILITY OF FELINE INTESTINE*

By BRADFORD N. CRAVER, M.D.
SUMMIT, NEW JERSEY

THIS paper reports experiments designed to elucidate the possible effect of roentgen-ray exposure in vitro on the motility of isolated strips of small intestine from the cat. Goldhaber and Back[1] in 1941 published an interesting series of in vitro experiments designed to determine the minimal dose of roentgen rays which would: (1) stop the beating of myocardial fragments from seven day old chick embryos; (2) stop the movements of intestinal strips from eighteen day old chick embryos, and (3) stop the ciliary activity of *Buffo viridis*. The minimal doses required ranged from 500,000 to 1,000,000 r, respectively. This report, which but recently came to our attention, summarizes the few previous studies of the effect of roentgen and γ-irradiation on the kinetic activity of cells and tissues in vitro. Those studies reported no changes. Only the experiments reported by Scott,[2] however, included studies made a sufficient number of days after exposure to allow for a latent period which might obtain before any effects became evident. He reported that the auricles of *Rana esculenta* exposed continuously to the unmeasured radiation from 5 mg. of radium in the form of radium bromide showed no significant contractile differences from the controls for six days or more after exposure. The heart, however, is notoriously resistant to the effects of irradiation,[2] whereas the intestine is known to be very sensitive and for this reason the present study was undertaken.

METHOD AND RESULTS

Five cats were employed in this study. All cats were killed after light anesthesia with sodium pentobarbital by opening the chest. The jejunum and ileum were removed for the experiments, carefully washed out with previously oxygenated ice-cold Locke's solution, divided into six approximately equal and consecutively numbered segments, with exceptions as noted, beginning with the proximal or jejunal end, and then stored in the refrigerator between layers of cotton soaked in oxygenated, cold Locke's solution. The technical irradiation factors in these experiments were: 120 kv., 8 ma., 7.5 inches target skin distance, output 640 r per minute. No filter was used save that inherent in the instrument. In a preliminary experiment the intestine of the first cat was exposed to 1,000 r two days after the intestine had been removed from the animal. Immediately thereafter a strip of jejunum and one of ileum were placed in continuously oxygenated, isolated, 100 cc. tissue baths at 39° C. and their longitudinal contractions kymographically recorded for over four hours by which time their activity had markedly diminished. The resulting records after comparison with previously secured controls suggested some stimulation of the contractile mechanism. The intestine of the second cat was divided into four equal segments, the first exposed to 2,000 r with the second kept as an unexposed control, the third exposed to 5,000 r with the fourth retained as an unexposed control. Immediately after exposure a strip of the segment exposed to 2,000 r and a contiguous strip from its control segment were arranged for kymographic recording and the longitudinal contractions recorded for 7.5 hours. No significant differences in the behavior of the two strips, either in respect to the type or over-all duration of the contractions, were observed. Three days after exposure three strips from the segment that received 5,000 r and three strips

* This paper is based on work performed under Contract Number W-7401-eng-49 with the Manhattan Project for the University of Rochester, Rochester, New York.

from its control segment were arranged in the previously described fashion, but again no significant differences were noted. The intestines of the last three cats were all treated as follows: Segment No. 1 was exposed to 1,000 r with No. 2 kept as control; segment No. 3 to 5,000 r with No. 4 as control; and segment No. 5 to 10,000 r with No. 6 as control. Kymographic recordings for 1.5 hours were secured immediately after exposure for one strip taken from the proximal end of each of the six segments and the same procedure was followed on each of the succeeding three days. No significant differences between the behavior of the exposed and the control strips were noted. The motility on the first day was excellent, on the second good, on the third fair, and on the fourth poor. The latent period between the placing of the strip in the bath and the onset of spontaneous motility varied from seconds on the first day to twenty to thirty minutes on the fourth, but in all respects the exposed and unexposed strips behaved similarly.

DISCUSSION

The doses of roentgen rays employed did not have any apparent effect on the contractile mechanism of the small intestine of the cat. The first experiment, inadequately controlled it is true, would suggest that roentgen-ray exposure of the small intestine two days after its removal from the animal might augment its action, although this putative action was probably illusory. Unfortunately, circumstances did not at the time permit the experiments required to settle this point. The results are consistent with Henshaw's views.[3]

SUMMARY

The exposure in vitro to doses of soft roentgen rays, varying from 1,000 to 10,000 r, of strips of small intestine from the cat did not appear to influence significantly their kymographically recorded motility.

The author thanks Mr. Robert Hay and Mr. Herbert Mermagen for arranging the roentgenologic exposures and Miss Mildred Taylor for technical assistance.

556 Morris Ave.
Summit. N. J.

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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Committee on Arrangements: To be appointed.

Thirtieth Annual Meeting: 1948, to be announced.

EDITORIAL

CANCER OF THE STOMACH

ACCORDING to Dr. Parran, Surgeon General of the United States Public Health Service, during the four years of World War II the American Armed Forces lost 300,000 men as a result of enemy action. During the same period an identical number of persons died from cancer of the digestive system, accounting for about 45 per cent of all cancer deaths in the United States. In one-third of these the cancer involved the stomach.

A lesion which still takes such a large toll of life merits our most earnest consideration. It is therefore very fortunate that periodical conferences dealing with gastric cancer are being arranged under the auspices of the National Advisory Cancer Council. The proceedings of the third conference were published recently.[1]

A perusal of the wealth of material reveals that the attack on this one of the most fatal diseases is conducted in various ways.

From the therapeutic standpoint the best attack, of course, continues to remain surgery. A very definite progress has been made during the past decade. Pack, who has contributed so notably toward the improvement of the surgical technique, states that the better end-results in gastric cancer may be attributed, among other things, to the introduction of extremely radical operative procedures such as total gastrectomy, transthoracic cardiectomy and removal of organs adjacent to the stomach that are involved by contiguity with the cancer. Although the immediate postoperative mortality may be greater than for the simple subtotal gastrectomy, the percentage of end-results is undoubtedly increased.

Radiation therapy, either as a primary agent in the inoperable cases or as an adjunct to surgery in the operable group, has a limited value. It seems that nothing significant has been added to what is already more or less generally accepted.

In the domain of research, however, considerable progress has been made and the Conference has dealt with several problems of great interest. Thus Strong gave further evidence to strengthen his conclusion, formerly arrived at, that hereditary cancer in mice can be induced by chemical means. For some time it was observed that gastric carcinoma and other types of neoplasia and hyperplasia occurred in mice following the subcutaneous injection of methylcholanthrene dissolved in sesame oil and that untreated descendants of such mice continued to develop similar lesions spontaneously. Strong now assumes that the manifold lesions arising just anterior to the pylorus in mice are biologically related and most probably are due to the process of hybridization, on the one hand, and to the induction of gene mutations by methylcholanthrene or one of its metabolites, on the other. This observation is the more remarkable since, as is known, gastric carcinoma is very rare in lower animals as contrasted with the high incidence in humans. The mice of Strong were studied histologically by McPeak and Warren who found that the microscopic characteristics of these gastric lesions are not altogether sufficient to permit an exact classification into benign or malignant tumors, a fact which somewhat complicates the issue. Lushbaugh performed a series of experiments on monkeys to determine if any damage resulted to the lungs from oil fogs used to screen Army personnel from enemy

[1] Conference on Gastric Cancer. *J. Nat. Cancer Inst.*, 1947, 7, 299–385.

observation and he accidentally noted that the monkeys developed a fatal gastric lesion. A given percentage of the monkeys died during or shortly after the 100 day exposure period. On necropsy hyperplastic gastritis, polyps and penetration of the submucosa by epithelial growths were observed due probably to the ingestion of a considerable quantity of oil. This oil was later found to be exceedingly rich in substances giving the absorptive spectra of carcinogenic hydrocarbons.

One of the monkeys described by Lushbaugh was killed one and one-half years later and postmortem examination revealed the presence of a severe atrophic gastritis. For a long time gastric atrophy had been assumed to be a late stage of hyperplastic gastritis and this observation seemed to prove it. The process, as a rule, was considered irreversible. Benedict, however, after a review of the literature on gastric atrophy and based on his own personal observations arrived at a somewhat different conclusion. He distinguishes between a localized and diffuse gastric atrophy. The former may occur in conjunction with ulcer and cancer or may be mixed with a chronic hypertrophic gastritis. The latter may be idiopathic or may be observed in association with deficiency diseases, notably pernicious anemia. Although pathologic evidence is as yet lacking, Benedict was able to confirm by gastroscopy that in some cases prolonged, intensive liver therapy resulted in definite improvement of the gastric atrophy. The well known high incidence of gastric tumors, especially in the diffuse atrophy of the mucosa of the stomach, was borne out in Benedict's series. Furthermore an unusually high incidence of tumor formations was found in other parts of the body.

Ivy and Cooke attempted to produce experimentally malignant transformation of gastric ulcer in rabbits. They used domestic and wild brown rabbits for this purpose. The ulcer was produced by excising part of the gastric mucosa. As a rule, such procedure leads in rabbits to the formation of a chronic callous ulcer with papillomatous overgrowth of the mucosal edge. To induce malignant degeneration methylcholanthrene was given daily per os. No detectable change of the ulcer was found in the domestic rabbits from three and one-half to five and one-half months postoperatively but epithelial cysts formed in three of the four wild rabbits after five to thirteen months.

The results of some other experimental investigations are also interesting, although their meaning is not as yet clear. Schiff and his co-workers found, for example, that if tracer doses of radioactive iodine are given the stomach concentrates this substance to a considerable degree and that the salivary glands excrete the radioactive iodine even in higher concentration than the stomach. Kelsey and Brunschwig, on the other hand, noted a selective capacity of the gastrointestinal cancers to concentrate quinine given either by mouth or by vein.

However important these experimental investigations may be in their scientific scope, obviously for the time being they can have but little influence on the practical aspect of improvement of the final results in cancer of the stomach. Therefore, as in the past, our only hope must remain in the establishment of an early diagnosis and if possible in the proper identification of the likely precursors of gastric cancer.

The question arose whether or not the introduction of some routine survey method, such as now successfully practiced in chest examinations, may not be of greater aid. Rigler and Kaplan have spent considerable time in trying to elaborate such a system but the difficulties encountered were considerable. Morbidity statistics show that only 3 out of 1,000 persons over forty years of age are apt to be afflicted with carcinoma of the stomach at any one time. A complete examination, therefore, by means of roentgenoscopy, spot roentgenograms and serial roentgenography of all asymptomatic individuals of the cancer-bearing age would be an ex-

pensive and time-consuming procedure which could not be utilized on a large scale. According to these investigators a better purpose is served by selecting the patients for routine periodic examinations on the basis of some precursory disease, lesion or symptom known to be associated with gastric carcinoma more frequently than in the general population.

Rigler and Kaplan in performing regular semi-annual roentgen examinations at the University of Minnesota Hospital in all patients with pernicious anemia found a rather high incidence of benign and malignant epithelial tumors of the stomach as compared to the paucity of gastric tumors detected in non-selective mass surveys. The investigations were gradually extended to other likely precursors of gastric carcinoma. State, Varco and Wangensteen of the same institution are carrying out at the present large-scale surveys on (1) patients over fifty years of age with histamine achlorhydria and hypochlorhydria, (2) patients with gastric polyp, (3) patients with pernicious anemia, and (4) relatives of patients with gastric carcinoma. It is also planned to investigate patients with atrophy of the lingual mucosa and/or severe pyrorrhea alveolaris as potential developers of gastric carcinoma.

Rigler and Kaplan suggest that for large-scale examinations some method of rapid photofluorography or cineroentgenography be seriously considered.

By introducing simpler procedures and by establishing properly selected groups of individuals to be examined it is hoped that through periodically repeated examinations cancer of the stomach may be detected at an earlier asymptomatic stage of the disease. This then would permit treatment under more favorable conditions, leading to an improvement of the final results.

T. LEUCUTIA

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer

MEETINGS OF THE ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Haddon Hall, Atlantic City, N. J., Sept. 16–19, 1947.

American Radium Society
Secretary, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: Chicago, Ill., 1948.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Hotel Statler, Boston, Mass., Nov. 30–Dec. 5, 1947.

American College of Radiology
Secretary, Mac F. Cahal, 20 N. Wacker Drive, Chicago 6. Annual meeting: Continental Hotel, Chicago, Ill., June 20, 1948.

Section on Radiology, American Medical Association
Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio. Annual meeting: Chicago, Ill., June 21–25, 1948.

Alabama Radiological Society
Secretary, Dr. C. S. Stickley, 515 Bell Bldg., Montgomery, Ala. Next meeting time and place of Alabama State Medical Association.

Arkansas Radiological Society
Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

Brooklyn Roentgen Ray Society
Secretary, Dr. A. H. Levy, 1354 Carroll St., Brooklyn 13, N. Y. Meets monthly on fourth Tuesday, October to April.

Buffalo Radiological Society
Secretary, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

Central New York Roentgen Ray Society
Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year. January, May, November.

Chicago Roentgen Society
Secretary, Dr. T. J. Wachowski, 310 Ellis Ave., Wheaton, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

Cincinnati Radiological Society
Secretary, Dr. Eugene L. Saenger, 735 Doctors Bldg., Cincinnati 2, Ohio. Meets last Monday of each month, September to May, inclusive.

Cleveland Radiological Society
Secretary, Dr. George L. Sackett, 10515 Carnegie Ave. Cleveland 6, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

Dallas-Fort Worth Roentgen Study Club
Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

Denver Radiological Club
Secretary, Dr. W. C. Huyler, 1619 Milwaukee, Denver 6, Colo. Meets third Friday of each month at Department of Radiology, Colorado School of Medicine.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

Florida Radiological Society
Secretary, Dr. J. A. Beals, St. Luke's Hospital, Jacksonville, Fla. Meets twice yearly, in April preceding annual meeting of Florida Medical Society, and in November.

Georgia Radiological Society
Secretary, Dr. Robert Drane, DeRenne Apartments, Savannah, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

Radiological Society of Kansas City
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

Illinois Radiological Society
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

Indiana Roentgen Society
Secretary, Dr. J. A. Campbell, Indiana University Hospitals, Indianapolis 7. Meets second Sunday in May.

Iowa X-Ray Club
Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

Kentucky Radiological Society
Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

Long Island Radiological Society
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

Louisiana Radiological Society
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

Louisville Radiological Society
Secretary, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Louisville General Hospital.

Michigan Association of Roentgenologists
Secretary, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

Milwaukee Roentgen Ray Society
Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

Minnesota Radiological Society
Secretary, Dr. Chauncey N. Borman, 802 Medical Arts Bldg., Minneapolis 2, Minn. Two meetings yearly, one at time of Minnesota State Medical Association the other in the fall.

* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

NEBRASKA RADIOLOGICAL SOCIETY
Secretary, Dr. O. A. Neely, 924 Sharp Bldg., Lindoln, Neb. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

NEW HAMPSHIRE ROENTGEN RAY SOCIETY
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

NORTH CAROLINA RADIOLOGICAL SOCIETY
Secretary, Dr. J. E. Hemphill, 323 Professional Bldg., Charlotte 2, N. C. Meets in May and October.

NORTH DAKOTA RADIOLOGICAL SOCIETY
Secretary, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings held by announcement.

OHIO STATE RADIOLOGICAL SOCIETY
Secretary, Dr. Carroll C. Dundon, 11311 Shaker Blvd., Cleveland. Meets during meeting of Ohio State Medical Association in Cincinnati, May, 1948.

OKLAHOMA STATE RADIOLOGICAL SOCIETY
Secretary, Dr. P. E. Russo, 230 Osler Bldg., Oklahoma City, Okla. Three regular meetings annually.

ORLEANS PARISH RADIOLOGICAL SOCIETY
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY
Secretary, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

PACIFIC ROENTGEN SOCIETY
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

PENNSYLVANIA RADIOLOGICAL SOCIETY
Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary, Dr. C. L. Stewart, Jefferson Hospital. Meets first Thursday of each month, October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY
Secretary, Dr. L. M. J. Freedman, 115 South Highland Ave. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

PORTLAND ROENTGEN CLUB
Secretary, Dr. Selma Hyman, University of Oregon Medical School, Portland, Oregon. Meets monthly 2d Wednesday, 8:00 P.M., Library of University of Oregon Medical School.

RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY
Secretary, Dr. Harry A. Miller, 2452 Eutaw Place, Baltimore. Meets third Tuesday each month, September to May.

RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY
Secretary, Dr. Robert M. Lowman, Grace-New Haven Community Hospital, New Haven 11, Conn. Meets bimonthly on second Thursday, at place selected by Secretary.

RADIOLOGICAL SECTION, LOS ANGELES CO. MED. ASSN.
Secretary, Dr. Moris Horwitz, 2009 Wilshire Blvd., Los Angeles 5, Calif. Meets on second Wednesday of each month at the County Society Building.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. Roy G. Giles, Temple, Texas.

RADIOLOGICAL SOCIETY OF NEW JERSEY
Secretary, Dr. Raphael Pomeranz, 31 Lincoln Park, Newark, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.
Secretary, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY
Secretary, Dr. Maurice D. Frazer, 1037 Stuart Bldg., Lincoln, Nebr. Meets in Salt Lake City, Utah, 1948.

ST. LOUIS SOCIETY OF RADIOLOGISTS
Secretary, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September.

SAN DIEGO ROENTGEN SOCIETY
Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION
Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY
Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

SHREVEPORT RADIOLOGICAL CLUB
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

SOUTH CAROLINA X-RAY SOCIETY
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

TENNESSEE RADIOLOGICAL SOCIETY
Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

TEXAS RADIOLOGICAL SOCIETY
Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

UTAH RADIOLOGICAL CONFERENCE
Secretary, Dr. Henry H. Lerner, School of Medicine, University of Utah, Salt Lake City 1. Meets 1st and 3rd Thursdays monthly from 7:30 to 10 P.M., Salt Lake County General Hospital, September to June.

UTAH STATE RADIOLOGICAL SOCIETY
Secretary, Dr. M. Lowry Allen, Judge Bldg., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

VIRGINIA RADIOLOGICAL SOCIETY
Secretary, Dr. E. L. Flanagan, 116 E. Franklin St. Richmond, Va. Meets annually in October.

WASHINGTON STATE RADIOLOGICAL SOCIETY
Secretary, Dr. Homer V. Hartzell, 310 Stimson Bldg., Seattle 1, Wash. Meets fourth Monday each month, October through May, College Club, Seattle.

X-RAY STUDY CLUB OF SAN FRANCISCO
Secretary, Dr. Ivan J. Miller, 2000 Van Ness Ave. Meets monthly on third Thursday at 7:45 P.M., first six months of year at Lane Hall, Stanford University

Hospital, and second six months at Toland Hall, University of California Hospital.

Cuba

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

Mexico

Sociedad Mexicana de Radiologia y Fisioterapia
General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

British Empire

British Institute of Radiology Incorporated with the Roentgen Society
Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

Faculty of Radiologists
Secretary, Dr. M. H. Jupe, 23 Welbeck St., London, W.1 England.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

Canadian Association of Radiologists
Honorary Secretary, Dr. E. M. Crawford, 2100 Marlowe Ave., Montreal 28, Que. Meetings January and June.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Société Canadienne-Francaise d'Electrologie et de Radiologie Médicales
Secretary, Dr. Origéne Dufresne, 4120 Ontario St., East, Montreal, P. Q.

Radiological Section of the Victorian Branch of the British Medical Association
Secretary, Dr. Keith Hallam, St. George's Hospital. K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

Section of Radiology and Medical Electricity, Australasian Medical Congress
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

Radiological Section, New Zealand British Medical Association
Secretary, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

South America

Sociedad Argentina de Radiologia
Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

Sociedad Peruana de Radiologia
Secretary, Dr. Julio Bedoya Paredes, Apartado, 2306 Lima, Peru. Meetings held monthly except during January, February and March, at the Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

Continental Europe

Société Belge de Radiologie
General Secretary, Dr. S. Masy, 111 Avenue des Alliés, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

Ceskoslovenská společnost pro röntgenologii a radiologii v Praze
Secretary, MUDr. Roman Blána, Praha XII, Korunní 160, Czechoslovakia.

Polish Society of Radiology
First post-war inaugural meeting will be held in Warsaw, May 22 and 23, 1947.

Warsaw Section, Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, Nowogrodzka 59, Warsaw, Poland. Meets monthly.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad. USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Société Suisse de Radiologie (Schweizerische Röntgen-Gesellschaft)
Secretary for French language, Dr. Babaiantz, Geneva.
Secretary for German language, Dr. Max Hopf, Effingerstrasse 49, Bern. Meets annually in different cities.

AMERICAN COLLEGE OF PHYSICIANS

The American College of Physicians will conduct its 29th Annual Session at San Francisco, California, April 19–23, 1948. General Headquarters will be at the Civic Auditorium. Dr. William J. Kerr and Dr. Ernest H. Falconer, both of San Francisco, are the Co-Chairmen for local arrangements and the program of Clinics and Panel Discussions. The President of the College, Dr. Hugh J. Morgan, Professor of Medicine at Vanderbilt University School

of Medicine, Nashville, Tennessee, is in charge of the program of Morning Lectures and afternoon General Sessions.

Secretaries of medical societies are especially asked to note these dates and, in arranging meeting dates of their societies, to avoid conflicts with the meeting of the College, for obvious mutual benefits.

RESEARCH FELLOWSHIPS—AMERICAN COLLEGE OF PHYSICIANS

The American College of Physicians announces that a limited number of Fellowships in Medicine will be available from July 1, 1948–June 30, 1949. These Fellowships are designed to provide an opportunity for research training either in the basic medical sciences or in the application of these sciences to clinical investigation. They are for the benefit of physicians who are in the early stages of their preparation for a teaching and investigative career in Internal Medicine. Assurance must be provided that the applicant will be acceptable in the laboratory or clinic of his choice and that he will be provided with the facilities necessary for the proper pursuit of his work. The stipend will be from $2,200 to $3,000.

Application forms will be supplied on request to The American College of Physicians, 4200 Pine Street, Philadelphia 4, Pa., and must be submitted in duplicate not later than November 1, 1947. Announcement of the awards will be made as promptly as is possible.

SECTION ON RADIOLOGY AMERICAN MEDICAL ASSOCIATION

The American Medical Association will hold its 1948 annual session in Chicago, Illinois, June 21–25. Those wishing to present papers before the Section on Radiology should communicate with the Secretary of the Section, Dr. U. V. Portmann, 2020 East 93d St., Cleveland 6, Ohio, before December 1, 1947.

ATOMIC RADIATIONS UNIT

Formation of an Atomic Radiations Unit in the Chemical Section of the Industrial Hygiene Division, United States Public Health Service, was announced by Dr. J. G. Townsend, Chief of the Division. Duncan Holaday, Engineer (R), is in charge of the new Unit.

The new Unit will advise and assist State industrial hygiene units in detecting and evaluating health hazards produced by the use of radioactive isotopes and high energy machines such as roentgen-ray machines and betatrons.

Radioactive isotopes are used primarily in scientific research. Roentgen rays are increasingly used in industry for the inspection of finished products. Fluoroscopes are fairly commonly used in the citrus fruit, tobacco, and retail shoe industries.

It is believed that institutions and industries are handicapped in their desire to use radioactive isotopes and high energy machines by their lack of information about the safe handling of dangerous quantities of radioactive materials. The new Atomic Radiations Unit, working through industrial units in the States, will help institutions and industries evaluate their hazards and establish safe working conditions.

AMERICAN RADIUM SOCIETY

The Twenty-ninth Annual Meeting of the American Radium Society was held at the Seaside Hotel, Atlantic City, New Jersey, on June 9 and 10, 1947, the President, Dr. Charles L. Martin of Dallas, Texas, presiding. Several excellent symposia were presented on the radiation treatment of various types of cancer and in due course of time these papers will be published in this JOURNAL.

The following officers were elected for the year 1947–1948: *President*, Dr. A. N. Arneson, St. Louis, Missouri; *President-Elect*, Dr. Maurice Lenz, New York; *First Vice-President*, Dr. William S. MacComb, New York; *Second Vice-President*, Dr. Leland R. Cowan, Salt Lake City, Utah; *Treasurer*, Dr. Howard B. Hunt, Omaha, Nebraska; *Secretary*, Dr. Hugh F. Hare, Boston, Massachusetts; *Member of the Executive Committee*, Dr. Charles L. Martin, Dallas, Texas.

The Thirtieth Annual Meeting of the Society will be held in Chicago, Illinois, in 1948. The place and dates will be announced later, as soon as the information is available.

Hugh F. Hare, *Secretary*

AMERICAN COLLEGE OF RADIOLOGY

At the Twenty-third Annual Meeting of the American College of Radiology held at Atlantic City, New Jersey, on June 8, 1947, the following officers were elected for the year 1947–1948: *President*, Dr. E. C. Ernst, St. Louis, Missouri; *Vice-President*, Dr. Charles L. Martin, Dallas, Texas; *Treasurer*, Dr. Warren W. Furey, Chicago, Illinois; *Secretary*, Mac F. Cahal, Chicago, Illinois.

The Twenty-fourth Annual Meeting of the College will be held in Chicago, Illinois, at the Continental Hotel on June 20, 1948.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

At the meeting of the Rocky Mountain Radiological Society held in Denver, Colorado, August 7–9, 1947, the following officers were elected for the coming year: *President*, Dr. James P. Kerby, Salt Lake City, Utah; *President-Elect*, Dr. Howard B. Hunt, Omaha, Nebraska; *First Vice-President*, Dr. Q. B., Coray, Salt Lake City, Utah; *Second Vice-President*, Dr. E. M. Hayden, Tucson, Arizona; *Secretary-Treasurer*, Dr. M. D. Frazer, Lincoln, Nebraska; *Historian*, Dr. John S. Bouslog, Denver, Colorado.

The recent meeting was a successful one, with over 165 registrants. The guest speakers were Dr. Lloyd F. Craver, Kenneth E. Corrigan, Ph.D., Dr. Eldwin R. Witwer, Dr. Claude Hunt, Dr. Leo G. Rigler, Dr. Lowell S. Goin and Dr. Edgar P. McNamee.

The next annual meeting, in 1948, will be held in Salt Lake City, Utah.

Maurice D. Frazer, *Secretary*

OHIO STATE RADIOLOGICAL SOCIETY

At the recent meeting of the Ohio State Radiological Society the following officers were elected for the coming year: *President*, Dr. Ralph W. Holmes, Chillicothe; *Vice-President*, Dr. Henry Snow, Dayton; *Secretary-Treasurer*, Dr. Carroll C. Dundon, Cleveland; *Executive Committee*, Dr. H. F. Fulton, Columbus and Dr. E. C. Elsey, Cincinnati.

The next meeting of the Society will be held in conjunction with the meeting of the Ohio State Medical Association in Cincinnati in May, 1948.

To The Editor:

Page xii of the advertising section of the July, 1947, issue of the AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY contains an advertisement announcing a grid front cassette and designated by the manufacturer as "Lysholm Grid Cassette" without any connotation as to the origin of the device. This grid cassette combination was devised by myself and we have been using two experimental models for nearly a year. It seems to have many uses and visiting radiologists have expressed interest in it. It was my understanding with the manufacturer, who also expressed an interest, that no announcement concerning the device would be made until my description of the cassette and its applications were published in a scientific journal. The terminology "Lysholm Grid Cassette" is technically correct since in that particular model a metal Lysholm grid is used as was in my original model. However, the designation implies that the device was originated by Lysholm which is not correct. For the sake of the record and my own interest in the matter, which is certainly not material, your readers might be interested in this clarification.

JOHN D. CAMP, M.D.
Mayo Clinic,
Rochester, Minnesota

BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.

Radium Lost and Found. By Robert B. Taft, M.D., B.S., M.A., F.A.C.R. Second edition. With an introduction by George E. Pfahler, M.D., Sc.D., LL.D., D.M.R.E. (Camb.), F.A.C.R. Cloth. Pp. 158, with 27 illustrations by Mercedes Hoshall, B.F.A. Charleston, S. C.: Walker, Evans & Cogswell Co., 1946.

Dr. Taft has reorganized and enlarged the fascinating story of lost and found radium which he first told eight years ago. The material in the new book is based upon years of experience by the author and many of his friends in hunting lost radium. The book is again dedicated "To That Mythical Little Animal of Unknown Origin, the Radium Hound." It will undoubtedly find interested readers in this atom-conscious age. Investigators using radioactive isotopes as tracers will admire the labors of their forefathers who for many years have traced lost radium, long before the atom bomb was ever heard of, by ingeniously combining a detective's skill with the expert handling of various detectors of radioactivity. These detectors were originally a photographic plate and a fluorescent screen, then gold leaf electroscopes and string electrometers which in turn around the thirties were replaced by sensitive Geiger counters. Around that time the author of the book had built a very compact, battery-operated counter for the special purpose of finding lost radium.

Radium tracing expeditions usually start in the room where the loss of radium has occurred or has first been noticed; they lead through elevators, chutes or stairways to trash disposal piles, incinerators, laundries, sewers, city dumps, even to farms where city ashes have been dumped on driveways or where city garbage has been fed to hogs. Taft describes numerous such radium hunts and most of them read like detective stories rather than sober scientific experiments. At the end of many long successful searches, radium was found in a living pig ("complete recovery of radium, complete loss of pig"), in the base of a bedpan hopper, in the lace of a patient's dress, in the needle holder of a phonograph, in deep mud under a boat, under new cement sidewalks, in a sewage disposal plant, in laundry vats, on trucks en route to the city dump, and many other unusual places. Most losses occur when bandages containing radium are removed from patients and thrown by accident into refuse receptacles whence they are carried to the incinerator or the dump. The longer the time interval between loss and start of search the smaller the chance for recovery. Although accurate statistics on radium losses are not available, Taft reports 187 losses of radium with 115 recoveries, 16 partial recoveries, 53 total losses and three unknown results. Although radium has been appropriated because of the attractive appearance of its metal containers or occasionally lost under suspicious circumstances, there is apparently no authenticated case in which radium was a stolen for a profit motive. An interesting chapter on damage to radium containers by accidental breakage or spontaneous explosions and an appendix discussing the construction of the author's portable Geiger counter complete this most fascinating story of radium lost and found.

Otto Glasser

Queensland Radium Institute, Queensland, Australia. Second Annual Report of the Honourable the Minister for Health and Home Affairs. For the Year ended 30th June, 1946. Pp. 23.

Although this center is called a Radium Institute, facilities for treatment with radium and roentgen rays are available. In Queensland, according to this report, one person in four is expected to have cancer; this incidence is about fifteen times the incidence of cancer in European countries. This enormous difference is largely due to a much greater prevalence of skin cancer. Eighty-two per cent of the population of Queensland live along the East coast of this province, and 24 per cent live in a tropical climate. Of "old patients" treated only a small proportion are said to be afflicted with recurrences; the greater number is made up of patients who present new lesions of the skin. It is not unusual to see patients who have been treated over the years for fifty or more malig-

nant conditions of the skin. During 1945, out of a total population of 1,052,000, 1094 persons died of cancer; fifty-one persons died of skin cancer.

The Institute, which occupies a wing of the Brisbane Hospital, has five sub-centers situated at Mater Hospital (Brisbane), Rockhampton (396 miles), Mackay (598 miles), Townsville (832 miles), and Cairns (1043 miles).

For cutaneous neoplasms (basal and squamous cell) of the torso or lower extremity, surgery is sometimes advised, but for most malignant lesions of the skin radiation treatment is employed. The kind of treatment varies according to the site, size, depth, extent and pathologic character of the lesions. Multiple lesions may require combined treatment (roentgen rays, implantation of radium, radon mould and radium plates). For primary melanoblastomas surgery is advised, and for inoperable extension to lymph nodes palliative roentgen treatment is employed. In skin cancer early treatment is emphasized. For epithelioma of the lip radium implantation is preferred, only superficial lesions being subjected to contact treatment with roentgen rays. As soon as the primary lesion has healed, affected tributary lymph nodes are excised en bloc. When these show rapid growth, roentgen treatment is used to check growth pending surgery. "Prophylactic" irradiation has been discarded.

For epithelioma of the tongue and floor of the mouth implantation of radon seeds rather than radium needles is preferred (average tumor dose 6000 r). Block dissection of involved lymph nodes is recommended; when an inoperable mass of nodes is present, implantation of radium or radon, with or without roentgen treatment, is employed. In cancer of the breast the rate of survival has been disappointing.

In chronic myeloid leukemia exposure of the entire body is favored when radioactive phosphorus is not available; this is combined with local irradiation of the spleen, when this organ is large. In chronic lymphatic leukemia, masses of nodes and the spleen are treated, and sometimes this is supplemented by roentgen treatment of the trunk through large fields. Radioactive phosphorus, when available, has been used in some cases of lymphosarcoma, leukemia and polycythemia vera; the results have been similar to those obtained with roentgen rays.

A. U. Desjardins

Medical Research: A Symposium. Edited by Austin Smith, M.D. Cloth. Price ,$5.00. Pp. 169, with 17 illustrations, including 10 in color. Philadelphia: J. B. Lippincott Company, 1946.

This small volume, written by eight men, discusses the various angles of medical investigation. The eight chapters deal with Fundamentals of Medical Research, Some Practical Aspects of Research, The Laboratory, The Manufacture and the Development of New Drugs, Medical Research in the University Medical School, Clinical Research with a Notebook, The Publicizing of Scientific Research, and Photography in Medical Research.

The outstanding contribution is written by Thorald Sollman, Dean Emeritus of Western Reserve University School of Medicine. This is an epitomized statement of his views based on many years of medical research and in association with others in this field. The chapter dealing with The Relation of Photography to Medical Research by Milton C. Bohrod and H. Lou Gibson is stimulating and contains some of the finest colored photographs illustrating medical topics which have been published.

This book should be of interest to some students of medicine or the medical sciences, to those of the non-medical public who desire to learn more about research in general, and to anyone who contemplates entering this field of human endeavor.

Cyrus C. Sturgis

A Memoir to the Academy of Sciences at Paris on a New Use of Sulphuric Ether. By W. T. G. Morton of Boston in the U.S.A. Presented by M. Arago in the Autumn of 1847. Paper. Price, $1.50. Pp. 24. New York: Henry Schuman, 1946.

This reprint, one of the most important of Morton's statements concerning his first public demonstration of ether with special reference to the relation of various other claimants to the origination of the fundamental concept, is of absorbing interest to those who have not the privilege of reading or owning one of the rare original copies. The credit for no other great discovery in the fields of medicine or science has ever been more confused and obscured than that of anesthesia. Its story has often been told as a romance, as a case for the jurist, as a congressional debate and as theatrical and impassioned personal claims. We have long since acknowl-

edged anesthesia as one of science's greatest gifts to humanity. We owe it to our sense of truth and fairness to read the original statements of Morton written by him in the heat of controversy in defense of his own achievements.

Morton's first publication on anesthesia was his "Remarks on the Proper Mode of Administration of Sulphuric Ether by Inhalation" which was issued in Boston in September, 1847. In November, 1847, Morton published in Paris a memoir in French addressed to the Academy of Sciences at Paris, an account of the ether controversy. In a calm and dignified manner he states his claims in relation to the events and to those of Wells and Jackson.

This statement was issued in English in Littell's Living Age in March, 1848. It represents the fullest and most complete account of the whole event in relation to all persons and circumstances involved and is fundamental in every consideration of the facts of this all important event. There is a foreword by John F. Fulton that is introductory and explanatory, part of which is recapitulated in this review. This brochure reprinted by Schuman will be of interest to all those not so fortunate as to have the rare original, but who do have an interest in one of the important landmarks of medical progress.

Frederick A. Coller

Journal of the History of Medicine and Allied Sciences. Vol. 1, No. 4, 1946. Anesthesia Centennial Number. Paper. Price, $2.50. Pp. 505–710, with illustrations. New York. Henry Schuman, 1946.

This issue of a new and important journal marks two anniversaries; the first of the Journal, and the one hundreth of the public administration of ether. The volume is worthy of both. Twenty-two articles are presented, all of them developing the historical backgrounds of anesthesia from differing viewpoints in a complementary fashion. It is impossible in a short review to enumerate and analyze each presentation but one can say that every paper is original and based on research that advances our knowledge rather than reiterates the facts that have become commonplace through past repetition.

An original and important aspect of the symposium is the inclusion of a number of studies of the original use of anesthesia in many countries about which the English medical literature has been silent. This issue of the Journal synchronized as it was with the celebration of the Centenary of the Public Administration of Ether at the Massachusetts General Hospital and because of its own importance is a volume that could well be bound alone as a work of fundamental worth in any medical library. The praise of this single issue is understated for those interested in medical historical material since the various presentations will become important as primary contributions to the history of one of medicine's most vivid achievements.

Aside from a most laudatory mention of this anniversary number of the Journal it is not beyond the scope of this review to draw attention of anyone who may read this to the Journal itself. A quarterly, now in its second year, it is already an important, attractive, and basic medium for the presentation of medical history in its broadest aspect. Mr. Schuman is to be congratulated upon his concept and I suspect his courage in attempting the production of a cultural rather than a practical venture. Doctor Rosen and his distinguished associate editors and consulting staff are to be praised for their efforts to carry on a journal devoted to the growth of the Health Sciences from earliest times to the present. In our professional lives we emphasize the practical. As we do so we tend to become static or to retrogress. It is only by a continuing study of our past that we will avoid the evils of practicality and advance as our works warrant.

Everyone interested in the past of medicine and in its future progress is urged to subscribe to and enjoy the authoritative and fascinating contents of the Journal of the History of Medicine and the Allied Sciences.

Frederick A. Coller

Vol. 58, No. 3

DEPARTMENT OF TECHNIQUE

Department Editor: Robert B. Taft, M.D., B.S., M.A., 103 Rutledge Ave.
Charleston, S. C.

A SIMPLE MOTORIZED ATTACHMENT FOR TOMOGRAPHY*

By ALLAN HURST, M.D., *and* A. S. WAINHOUSE, R.T.
DENVER, COLORADO

TOMOGRAPHY in chest diseases is now a well established diagnostic procedure in most tuberculosis hospitals and sanatoria. The original model of the roentgen-ray attachment was worked by a string arrangement or by manually moving the cassette in one direction and the tube in the opposite direction. The objections to this technique were: (*a*) exposure of the technician to a high dosage of roentgen rays; (*b*) lack of uniformity in the speed of movement of the tube. A third but minor objection was need for an additional switch to the control stand, or an extra technician

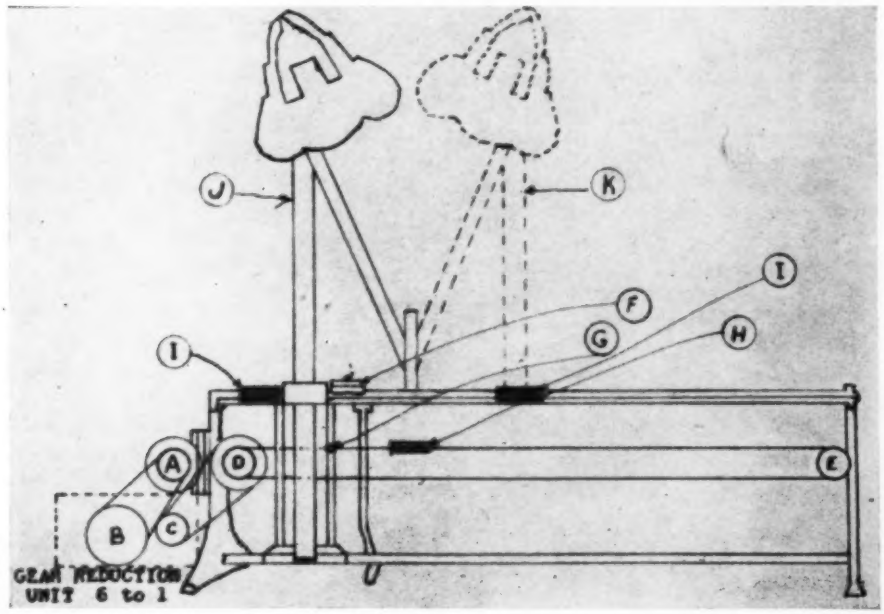

Fig. 1. *A*, ¼ HP. G. E. motor 115 V single phase 1725 RPM—pulley and V-belt drive to (*B*). *B*, input pulley (fast) of 6 to 1 gear reduction unit—V-belt drive to (*A*). *C*, output pulley (slow) of 6 to 1 gear reduction unit—V-belt drive to (*D*). *D*, jackshaft with V-belt pulley and steel cable pulley—V-belt drive to (*C*); cable drive to (*E*). *E*, idler pulley for steel cable—cable drive from (*D*). *F*, switch box mounted on tube stand locking device on tube column. *G*, hook and lug for attaching cable to column. *H*, turnbuckle for taking up the stretch of the steel cable. *I*, cams (2) for operating "limit" switches for travel limits. *J*, position of tube at the beginning of planigraph travel. *K*, position of tube at end of the planigraph travel.

A sheet metal hood covers *A-B-C-D* for protection of the operator; a sheet metal hood covers *E*.

* From the National Jewish Hospital at Denver, and the University of Colorado School of Medicine.

to operate the controls while the tube and cassette were being moved.

Because of these difficulties the roentgen technicians took as few tomograms as possible, and the staff was reluctant to utilize this diagnostic procedure to its fullest extent.

Careful investigations were made into the feasibility of motorization of the equipment. The drawing (Fig. 1) illustrates the installation of a $\frac{1}{4}$ H.P. motor and cables, which is operated very easily by the technician at the control stand. The tube and cassette can be moved in only one direction at this time, but additional equipment may be added to move it in both directions.

The ease and simplicity of operation has increased the number of tomograms taken at this hospital. The technique has not been changed, and the distance of tube from patient is still calculated in the same way. To our best knowledge this is the simplest motorized equipment for tomography other than the larger elaborate machine which takes planar roentgenograms in all directions.

National Jewish Hospital
Denver 6, Colo.

We are indebted to the General Electric X-ray Corporation and especially to their Denver office for help in designing the motorized unit.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD

LIST, CARL F., and HODGES, FRED J. Intracranial angiography. 1. The diagnosis of vascular lesions. *J. Neurosurg.*, Jan., 1946, *3*, 25–45.

With cerebral angiography the site of a suspected vascular lesion and often its anatomic character may be revealed. It is indicated in suspected vascular lesions of the brain whenever surgical treatment is under consideration and a precise diagnosis is required for such therapy. It is contraindicated in very old patients and those with far advanced arteriosclerosis, hypertension, cardiac decompensation, or recent embolic or thrombotic episodes. It is likewise contraindicated in most cases of acute intracranial hemorrhage unless conservative management carries greater risk than surgical treatment.

In carotid arteriography the carotid bifurcation is surgically exposed and under carefully controlled technique thorotrast is injected into either the beginning of the internal carotid or the common carotid artery. The injection is carefully synchronized with roentgen exposures of the head consisting of stereoscopic lateral and single anteroposterior films.

Vertebral arteriography is most easily performed by retrograde injection of the subclavian artery.

Thirty-five cases of vascular intracranial lesions have been studied by this method. These have been divided into the following groups with case histories and very good illustrations exemplifying each of the groups. Nineteen cases are briefly reviewed.

(1) *Vascular occlusion and coarctation.* Angiography is an excellent method to determine the presence and site of an arterial obstruction. Narrowing of the caliber of a vessel as well as thrombotic occlusion may be demonstrated and in chronic encephalopathies it may be possible to determine whether a lesion is inflammatory or of vascular origin.

(2) *Intracranial aneurysms.* Often the location and size of the aneurysm is clearly shown and sometimes multiple aneurysms are revealed. However, a clot may obliterate a portion of the sac, or a sac may be too small to retain the contrast medium. The aneurysm may appear larger than the actual size if a covered perforation is present that is walled off by thickened leptomeninges. Correct diagnosis of an aneurysm of the anterior cerebral artery may be rewarded by brilliant surgical results. A differentiation between parasellar tumor and aneurysm is possible only by angiography.

(3) *Arteriovenous fistula of the internal carotid artery in the cavernous sinus.* In such cases arteriograms show direct passage of the contrast medium from the carotid into the venous system with no filling or minimal filling of the cerebral arteries. Patients with arteriovenous fistula tolerate the ligation of the carotid very well. Demonstration of the main venous return is helpful in planning the surgical treatment of pulsating exophthalmos.

(4) *Vascular malformations.* Vascular anomalies have been classified as arterial, capillary, venous and arteriovenous malformations. Except for the capillary anomalies they can be demonstrated by angiography. Of these the cirsoid or racemose angioma is most common and it is of the arteriovenous type. The angiographic appearance of arteriovenous malformations may have superficial resemblance to angioblastic meningiomas or highly vascular glioblastomas, but these neoplasms always cause considerable displacement of the main cerebral vessels and their blood supply never assumes the huge and bizarre proportions found in arteriovenous malformations.—*K. K. Latteier.*

HAMBY, WALLACE B. Gross intracerebral hematomas; report of 16 surgically treated cases. *New York State J. M.*, April 15, 1945, *45*, 866–876.

Sixteen cases of gross intracerebral hemorrhage are described. All were drained, with 14 recoveries and 2 deaths. Seven of the cases were associated with cerebral arterial disease and 5 with brain tumors, 1 was proved and 3 suspected to be due to ruptured aneurysm of the major blood vessels, and 1 case was of de-

layed post-traumatic intracerebral hemorrhage. The article is illustrated diagrammatically by superimposing diagrams of the position of the lesions and the operative approaches on air roentgenograms or roentgen plates of the skull. The 16th case—the one of post-traumatic hemorrhage in which the patient fell 18 feet—is illustrated with roentgenograms showing a shift in the position of the pineal shadow. Immediately after the accident it was in the midline; a week later it had shifted 1 cm. to the left. Immediately after drainage it was in the midline, eleven days later it was shifted to the right; 128 days later the shadow of the cavity was smaller and denser and the pineal shadow was in the midline. Examinations are to be made every six months until its position becomes stabilized.

Progress of these lesions can be checked by flushing the cavity with thorium dioxide suspension which precipitates on the walls of the cavity and makes later roentgen examination possible.—*Audrey G. Morgan.*

Matson, Donald D., and Wolkin, Julius. Hematomas associated with penetrating wounds of the brain. *J. Neurosurg.*, Jan., 1946, *3*, 46–53.

Intracranial hematomas may arise distant to the wound of entrance in the presence of a penetrating wound of the brain. If a foreign body is visualized on the roentgen examination close to the cortex of the side opposite that of entrance, its location may mark the end of the tract through the brain, but it may also have reached the meninges or skull of the opposite side and bounced back into the brain without fracturing the bone. This situation is likely to be associated with hemorrhage into the subdural or subarachnoid spaces or into the brain itself. If the hemorrhage is limited to the extradural or subdural spaces or to any one area of the cerebrum so that a localized subcortical hematoma is formed, then surgical evacuation is often possible and an early attack may be life saving.

In through and through wounds of the brain, the wound of exit always exhibits greater damage than the wound of entrance and frequently is the site of a large hematoma. It therefore should be handled first since early evacuation of a hematoma or collection of macerated brain tissue will usually result in immediate improvement of the patient's general condition.

The authors present briefly case histories illustrating these two types of injuries.—*K. K. Latteier.*

Smolik, Edmund A., Blattner, Russell J., and Heys, Florence M. Brain abscess associated with congenital heart disease. *J.A.M.A.*, Jan. 19, 1946, *130*, 145–147.

The authors report a case of brain abscess associated with congenital heart disease and outline the mode of treatment which led to complete recovery from the abscess. They state that the association of brain abscess with congenital heart disease has not been emphasized sufficiently in the medical literature. They refer to the report of Robbins, who found 3 cases of brain abscess associated with tetralogy of Fallot in a series of 58 cases of congenital heart disease discovered at autopsy. This report included 23 similar cases reviewed in the literature.

The present case report was of a nine year old white girl. At two months of age a diagnosis of congenital heart disease had been made. According to her parents, however, the patient had never suffered from "heart trouble" and was never cyanotic. Six weeks before admission she suffered a chill and felt feverish, but recovered in twenty-four hours. Two weeks later she began to have severe recurrent frontal headaches associated with vomiting. The clinical diagnosis of brain abscess was made and was verified by ventriculography. Ventricular drainage was performed for relief of pressure and later 110 cc. of thick pus was aspirated from the left frontal area. Seventeen days later the abscess capsule was drained of 180 cc. of pus and the capsule marsupialized. One year later the patient was entirely symptom free and had apparently made a complete recovery. The only confirmatory signs of congenital heart disease in this case were a prominence in the region of the pulmonary artery as seen in the roentgen examination and the electrocardiographic findings of variable T waves and rotation of the electrical axis about 180 degrees from normal.

The diagnosis of brain abscess would probably be made more frequently if brain abscess were considered more generally whenever signs and symptoms of central nervous system involvement develop in a patient with congenital heart disease. Frequent attention has been drawn to the presence of sepsis in the lesser circulation, which, by direct passage to the central nervous system, explains the development of brain abscess.—*Charles B. Cobern.*

TROLAND, CHARLES E., BAXTER, DONALD H., and SCHATZKI, RICHARD. Observations on encephalographic findings in cerebral trauma. *J. Neurosurg.*, Sept., 1946, *3*, 390–398.

The authors reviewed encephalographic findings in a series of 261 patients, 206 of whom had had cranial trauma. Abnormal encephalograms were found in 74 per cent of the cases of head trauma. Unilateral dilatation of the ventricles was found in 29 per cent; symmetrical bilateral dilatation of the ventricles was found in 16 per cent of these cases, and asymmetrical bilateral dilatation in 29 per cent.

The mechanism of such dilatation is debatable, but in the majority of cases of symmetrical enlargement of the lateral ventricles and the third ventricle it is due to generalized loss of cerebral substance with secondary dilatation of the cerebrospinal system. Secondary fibrosis interfering with absorption of the fluid must also be considered. When, however, the third ventricle is not enlarged the dilatation is most likely due to diffuse cerebral atrophy secondary to trauma. In bilateral asymmetrical enlargement of the lateral ventricles the side of the greatest enlargement of the lateral ventricle was always on the side of the injury in both open and closed head injuries. With unilateral enlargement of the lateral ventricles there was direct loss of cerebral substance without diffuse cerebral change.

In checking the appearance of the ventricles on the day following the encephalography, enlargement was often more marked, parencephalic cysts often became visible on the later films, and at times a peculiar bulging of the interventricular septum was found. These studies indicated that existing brain atrophy was at times much more obvious on the second day and that the differential diagnosis between a space-occupying process and atrophy was facilitated in some cases by the follow-up study. —*K. K. Latteier.*

THOMPSON, RAYMOND K. Cystic cerebellar arachnoiditis. *J. Neurosurg.*, Nov., 1946, *3*, 461–468.

Cystic cerebellar arachnoiditis is a pathological state of scarring of the leptomeninges in the posterior cranial fossa, resulting in an internal hydrocephalus and a cystic accumulation of fluid at the site of the cisterna magna. It is most probably the result of a bloody, bacterial or contiguous inflammatory reaction in the subarachnoid space.

This cyst acts as a space-consuming mass in the posterior fossa, elevating the cerebellar hemispheres and pushing the cerebellar tonsils into the foramen magnum, and thereby partially obstructing the flow of the cerebrospinal fluid.

Such a cyst may be the result of a mild trauma and manifest itself by signs secondary to blockage of the flow of cerebrospinal fluid or by local pressure effects. The former produces headache, papilledema, bradycardia, abducens paralysis, episodes of syncope, transient episodes of blindness, etc., while the latter produces nystagmus, ataxia, partial or complete paralysis of the 5th, 7th or 8th cranial nerves, etc. These cannot be clinically differentiated from the picture produced by a primary neoplasm unless the relationship to trauma or infection arouses suspicion. Skull roentgenograms and spinal fluid studies are of no value in the differential diagnosis.

The author describes in detail an illustrative case of the disorder. The roentgen studies in this case were negative except for symmetrical dilatation of the lateral, 3rd and 4th ventricles with rostral angulation of the aqueduct and 4th ventricle. At operation a cyst was found occupying the lower right half of the posterior fossa and bulging into the foramen magnum. There was elevation of the right cerebellar hemisphere and flattening of the cerebellar tonsils which were pushed anteriorly and down into the foramen magnum against the medulla.

The course of the patient's symptoms are very well correlated by the author with the neurologic and operative findings. He also points out the possible relationship of this condition to post-traumatic suboccipital neuralgia.—*K. K. Latteier.*

POSNER, MARVIN, and HORRAX, GILBERT. Eye signs in pineal tumors. *J. Neurosurg.*, Jan., 1946, *3*, 15–24.

Material for this study consisted of 16 cases in which a diagnosis of pineal tumor was made at the Lahey Clinic. In 11 of the 16 patients the lesion was verified histologically. In the other 5 patients the clinical picture, the ventriculogram, and the course following decompression and radiation therapy made the diagnosis sufficiently certain to include them in this survey.

General features shown by these patients included: (1) increased intracranial pressure; (2) eye signs, such as impaired pupillary reac-

tions, limited extraocular motion, nystagmus and strabismus; (3) central deafness; (4) cerebellar signs. In addition, other general disturbances of function were present including endocrine dysfunction, diabetes insipidus, and dystrophia adiposogenitalis.

The eye signs in 16 cases of pineal tumors are tabulated and the following data may be summarized: (1) Dilated pupils were present in 31 per cent of cases and in 50 per cent there was impaired reaction to light. Reaction of the pupils on accommodation was impaired in only 12 per cent of the cases. (2) Papilledema was present in 56 per cent of the cases, with an average of 4 diopters elevation. (3) Upward gaze was limited in 31 per cent of the cases.

Observation of the fundi, the extraocular movements and the pupillary reactions may help formulate the diagnosis of a pineal tumor when seen in conjunction with ventriculograms showing the characteristic defect in the posterior part of the third ventricle.

An accurate diagnosis may save the patient the risk of a craniotomy on the basis of a mistaken diagnosis of cerebellar neoplasm.

The patient with a pineal tumor can usually be offered a better prognosis by subtemporal decompression and radiation therapy.—*K. K. Latteier.*

Davidoff, Leo. M. Coarctation of the walls of the lateral angles of the lateral cerebral ventricles. *J. Neurosurg.*, May, 1946, *3*, 250–256.

In cooperation with the Radiographic and Pathological Departments of the Jewish Hospital of Brooklyn, the author examined 64 brains taken routinely from cases without brain tumor or any other known neurological disease. In 4 cases he found an asymmetry of the lateral ventricles on both postmortem pneumoventriculograms and in the brain specimens on coronal sections. In addition, 6 cases of asymmetry of the ventricles were observed only on the roentgenograms and 10 cases in which deviations of a similar nature were seen only on coronal sections of the brain.

In anteroposterior encephalograms the asymmetry consists of a normal looking "butterfly wing" pattern of the ventricle on one side and a truncated one on the other side. In brain specimens showing asymmetrical developments of the two lateral ventricles, closely resembling the encephalograms, there appeared to be a coarctation of the adjacent walls of the lateral ventricles on the side of the smaller ventricle. In some specimens the adhesions were incomplete so that beyond the truncated end of the ventricle and the site of adhesion was a small cavity. Microscopic examination showed no degenerative changes or cellular proliferation. No evidence of inflammatory reaction, gliosis, or fibrosis was found in any of the sections examined.

It is the author's opinion that the coarctation of the cerebral ventricular walls occurs during the developmental period of the brain and that it can be classed as a congenital deformity.—*K. K. Latteier.*

NECK AND CHEST

Stuart, F. G. Pathological manifestations and anatomical variations in pre-enlistment chest roentgenograms. *Canad. M. Ass. J.*, May, 1945, *52*, 477–481.

The author summarized his findings in a series of 19,050 pre-enlistment roentgenograms of the chest. He found that healed primary tuberculosis occurred with equal frequency throughout all parts of both lungs. Reinfection tuberculosis was found to be predominantly apical.

The parenchymal components of primary tuberculosis showed a 30 per cent greater tendency to undergo complete roentgenographic resolution than did the hilar components.

Obliteration of the costophrenic sulcus was considered as being most often of primary tuberculous origin.

At least 0.2 per cent of the adult population examined revealed roentgen evidence of lung disease of which they had not been previously aware.

When the cardiothoracic ratio was 50 per cent or over, there was an even chance that cardiac disability would be found.

The importance of demonstrating apical lesions by resorting to special lordotic projections or films made with the two angled tube is excellently demonstrated.—*Philip J. Hodes.*

Rochat, Paul. 5000 radiophotographies à Lausanne: 1943 à 1945. (Five thousand photoroentgenograms at Lausanne: 1943–1945.) *Radiol. clin.*, Jan., 1946, *15*, 49–53.

The author, who is school physician of Lausanne, discusses 5,000 photoroentgenograms of 90 per cent of the students and 30 per cent of the teaching force of that city. A decision as to whether the subjects have tuberculosis can only be made if the photoroentgenography is sup-

plemented by roentgenoscopy and roentgenography. In many cases the Pirquet reaction and red cell sedimentation rate were also obtained.

In 21 cases, there were marked sequels of tuberculosis, such as pleural adhesions, calcifications, etc. There were 17 cases with suspicious shadows and 9 with definite pathology. Three of these cases with pulmonary infiltration, resembling the initial foci of Malmros and Hedval are described in more detail. These initial foci generally show a progressive course with softening and ulceration. These cases require long and careful supervision. Photoroentgenograms of the 3 cases are given.—*Audrey G. Morgan.*

HUMBERT, R. Les examens radiophotographiques dans le canton de Neuchâtel. (Photoroentgenographic examinations in the canton of Neuchâtel.) *Radiol. clin.*, Jan., 1946, *15*, 37–49.

The early detection of tuberculosis has become particularly important with the increase of the disease from the malnutrition and poor hygenic conditions brought about by the war. But important as diagnosis is it must be supplemented by increased facilities for hospitalization, helping the patients to readapt to social life when they are discharged and giving their families material support while they are in hospital.

The author discusses the advantages of photoroentgenography as compared with simple roentgenoscopy, though both methods have their indications. The films should be interpreted by a committee made up of a specialist in tuberculosis, one in internal medicine, one in roentgenology and a general practitioner. As soon as possible after they are examined the subjects are notified of the results of the examination. To Class A, in whom no roentgen signs of tuberculosis have been detected the notice states that there are *at present* no signs of disease, bearing in mind that such signs may appear quite soon after a negative roentgen examination. Those in Class B are notified that the findings indicate that they should have a complete medical examination and those in Class C that medical examination and treatment are urgent.

Surprisingly enough, a higher percentage of involvement was found in adults than in students. Among 10,805 students there were pathological findings in 0.9 per cent, among 14,173 adults in 1.66 per cent and among 4,078 military recruits in 0.5 per cent.

He discusses the question of whether examination should be made compulsory or remain voluntary and decides in favor of voluntary examination but with increasing educational effort so that increasing numbers of the population will come for voluntary examination.

A resolution adopted by the Roentgen Society declared in favor of compulsory examination with the appointment of a committee to coordinate the work in photoroentgenography, in collaboration with social and medical organizations interested in the question.—*Audrey G. Morgan.*

SCHINZ, H. R. Die Schirmbildphotographie. (Photoroentgenography.) *Radiol. clin.*, Jan., 1946, *15*, 36.

The importance of roentgen examination of the Swiss people in the detection and treatment of tuberculosis has only recently been recognized. In the course of the past year 16,000 roentgen examinations have been made at the Roentgenological Institute in Zürich. It is important to collect accurate statistics and to differentiate between the number of findings and the number of persons examined for often there are several different findings for a single individual.

As was to be expected the pathological findings among the civil population were much greater than in the army, 16.5 per cent as compared with 7.5 per cent. Among 100 pathological findings in the civil population, 30 were very important, 26 relatively important and 44 unimportant, while the corresponding figures for the army were 17, 24 and 59. Among 5,300 pathological findings there were 7 cases of tuberculosis that had not been diagnosed before, that is 0.13 per cent. Calculating this percentage for the 3,000,000 of Switzerland would give 4,000 new cases of open tuberculosis. This figure alone shows the necessity for roentgen examination on the whole population. This would show the infectious cases and they should be reported to the Tuberculosis League; it is of no use to detect the infectious cases unless they are given treatment to render them non-infectious. (Author's abstract. Complete article appears in *Schweiz. med. Wchnschr.*—*Audrey G. Morgan.*

MYERS, J. A. The establishment and use of fundamental procedures in tuberculosis con-

trol. *Pub. Health Rep.*, Nov. 1, 1946, *61*, 1563–1583.

This is a report of the tuberculosis control work in Minneapolis, Minn., for the past twenty-five years. Its effectiveness is proved by the fact that the tuberculosis mortality has been reduced from 120 per 100,000 in 1920 to 27.1 in 1945. Every promising method of control has been tried and many early erroneous impressions have been corrected. For instance, it has been found that primary tuberculosis does not require treatment; children with primary tuberculosis did as well without as with treatment.

But reinfection is an entirely different matter. The tuberculin test alone only proves the presence of infection. It gives no information as to whether the case is one of primary infection or reinfection. Neither is roentgen examination pathognomonic. Lung calcification may be caused by other conditions than tuberculosis. But no case of proved tuberculosis has been found among individuals who did not react to tuberculin. Therefore all persons who react positively to tuberculin should be given roentgen examinations every six to twelve months. Roentgen shadows appear before clinical signs of disease, so this examination is important. Cases that have not yet become infectious can be treated successfully with ambulatory artificial pneumothorax. All patients who have become infectious should be hospitalized. The objection that there are not enough beds is not a valid one. The public should see that there are enough beds.—*Audrey G. Morgan.*

Biggs, A. D. A roentgen ray and clinical study of primary tuberculosis. *Arch. Int. Med.*, April, 1946, *77*, 393–404.

In this study 460 children were studied and tested by the intradermal injection of a purified protein derivative and the Vollmer patch test. Of the total, exactly one-fourth, or 115, reacted to at least one of the tests. Since all tuberculin tests are based on an allergic phenomenon, it follows necessarily that none is infallible. The possibility of false negative reactions and false positive reactions must always be borne in mind. For this reason, it was considered necessary to keep each positive reactor under close clinical observation and to study him with serial roentgenograms.

As to the nature of primary tuberculosis of the lungs, it is believed by the author to be a subclinical disease. It cannot be detected by making a physical examination or by making a blood count or by keeping a record of the child's weight and growth. History of exposure is the only satisfactory criterion by which it may be suspected. A tuberculin test is the only efficient means of detecting it. Serial roentgenograms are the most satisfactory means of following its course.—*James J. McCort.*

Hiatt, Joseph S., Jr., and Martin, Donald S. Recovery from pulmonary moniliasis following serum therapy. *J.A.M.A.*, Jan. 26, 1946, *130*, 205–206.

This case of severe pulmonary moniliasis is presented because of the unusual immunologic findings and because of the dramatic recovery which followed the administration of immune serum.

A white woman, aged forty-four, married, a housewife, was admitted with the chief complaints of malaise, fatigue, cough and loss of weight for the preceding two months. Following onset of her symptoms she had a cough, productive of 1 tablespoon of mucoid, odorless sputum daily. She noted afternoon temperature elevation as high as 39.4° C. (103° F.) but no frank chills, chest pain, hemoptyses or night sweats. Iodides were administered by her physician but had to be discontinued because of the appearance of a pustular eruption on the face. Three weeks prior to admission she received, over a ten day period, a course of one of the sulfonamides with some subjective improvement. *Candida albicans* was isolated from the sputum on numerous occasions. Fluoroscopic and roentgenographic examinations of the chest showed diffuse densities throughout both lung fields, most likely due to infiltration, with lesions at the left base somewhat coalesced. The roentgen findings were interpreted as being consistent with a diagnosis of a diffuse bronchomycotic infection. The patient was skin tested with an autogenous vaccine of *Candida albicans* isolated from her sputum, and the reaction was negative. No agglutinins for the fungus could be found in the patient's serum. Because of a previous experience with a patient suffering from North American blastomycosis who had the same immunologic findings, i.e. negative skin test to *Blastomyces* vaccine, a negative complement fixation test and a positive immediate reaction to an anti-*Blastomyces* rabbit serum, it was decided to test this patient

with serum of a rabbit which had been previously immunized with *Candida albicans*. Injection of 0.1 cc. of the anti-*Canadida albicans* rabbit serum resulted in the formation of a wheal pseudopodia surrounded by a 5 cm. zone of erythema. Hypersensitivity to rabbit serum was excluded by injection of 0.1 cc. of normal rabbit serum, to which there was no reaction. The immunologic findings were interpreted as indicating that the patient was flooded with an excess of the fungus antigen, which inhibited both the agglutination reaction and the skin test to the vaccine. The patient was given immune anti-*Candida albicans* rabbit serum subcutaneously, beginning with 0.1 cc. of a 1:10 dilution, and the dose was increased by 0.1 cc. daily until a dose of 0.9 cc. was reached. The desensitization series was repeated twice. Following serum therapy there was a total remission of all subjective symptoms. Follow-up roentgenograms of the chest were interpreted as essentially normal. The skin test to *Candida albicans* has remained negative but the agglutinins were still positive in a 1:80 dilution.—*Samuel G. Henderson.*

HIGH, ROBERT H., and ZWERLING, HENRY B. Variation with age in the frequency of tuberculous pulmonary calcification. *Pub. Health Rep.*, Dec. 6, 1946, *61*, 1769–1782.

Calcification in the lung parenchyma or tracheobronchial lymph nodes frequently follows tuberculous infection in children but is much rarer in adults. In adults healing is generally by fibrosis.

The authors therefore made a study of the variations in frequency of calcification in a group of 1,457 American Indian children who had been used as controls in testing the effectiveness of BCG vaccine. During the period of observation 198 cases of tuberculosis occurred and calcification later developed in 49 of these. It was found that children who develop a tuberculous lesion before the age of five years have 7 chances in 8 of developing calcification, between five and nine, 5 chances in 8, ten to fourteen, 3 chances in 8 and fifteen to nineteen 1 chance in 8. The percentage of calcifications varies not only with age but with the type of tuberculosis. There is no significant difference in the sexes. Calcification is more frequent on the right side than on the left, 71.4 per cent on the right and 36.7 per cent on the left. This closely follows the distribution of the local lesions which were on the right in 61.6 per cent of the cases and on the left in 46 per cent.

In addition to these 198 cases of tuberculosis 402 children became sensitive to tuberculin during the period of observation. No evidence of tuberculosis was seen in this group though roentgenograms were made frequently. Only 2.2 per cent of these children developed calcification as compared with 24.7 per cent in the group with tuberculosis. From this it would appear that most tuberculous calcifications are preceded by lesions that can be demonstrated by roentgen examinations.

Tables and charts showing the details of the findings are given.—*Audrey G. Morgan.*

CASTELLANOS, AUGUSTIN, and GALAN, ENRIQUE. Sarcoidosis (Besnier-Boeck-Schaumann's disease). *Am. J. Dis. Child.*, May, 1946, *71*, 513–529.

This paper is a case report of sarcoidosis occurring in a six year old white Cuban boy. The disease started when the child was three years old with a gradual onset, prolonged fever and chronic polyarthritis deformans, with splenomegaly simulating Still's disease. The clinical picture was characterized by a miliary-like mottling of both lungs as shown in the roentgenograms of the chest, enlarged mediastinal and peripheral lymph nodes, a symmetrical erythematomacular cutaneous eruption on the cheeks, nose, shoulders and arms with brownish pigmentation and small telangiectases and atrophy of the epidermis. Ocular manifestations were observed such as moderate exophthalmos, recurrent internal strabismus, congestion of the conjunctivas, a pinpoint non-vesicular keratitis, involvement of the uveal tract and synechia of both irises.

Typical granulomas with or without multinucleated giant cells, but formed by epithelioid cells like those reported in sarcoidosis, were found in the subcutaneous tissue and peripheral muscle (deltoid). A diffuse infiltration of epithelioid cells was observed in the lymph node, which was excised, which had the characteristics of a reticuloendotheliosis. Diagnostic puncture of the lung and aspiration of the sternal marrow yielded numerous histiocytes and multinucleated cells respectively, those found in the bone marrow being similar to the giant cells seen in sarcoid granuloma.

The involvement of the large joints in the form of a chronic polyarthritis deformans was an unusual feature of the case and no similar instance could be found in the literature. No

roentgenographic examinations of the joints were made.

The condition was complicated by tuberculosis as indicated by a late strongly positive tuberculin reaction, a fibrinous pleurisy and a pneumonic process in the lower right lung, regarded by the authors as due to tuberculous lobular involvement. A footnote of the case history states that after this paper was submitted for publication the patient developed a Pott's abscess of the dorsal spine and died later from tuberculous meningitis, secondary to the abscess.—*R. S. Bromer.*

High, Robert H. Calcifications in the spleen; occurrence in histoplasmin and tuberculin reactors. *Pub. Health Rep.*, Dec. 6, 1946, *61*, 1782–1786.

Calcifications of the spleen may be produced by various causes but it has been believed generally that tuberculosis is the most frequent cause.

In 1945 the Tuberculosis Control Division of the United States Public Health Service, in cooperation with the Board of Education, the City Health Department and the Tuberculosis Society of Kansas City, Missouri, made histoplasmin and tuberculin tests and chest roentgenograms of over 17,000 patients.

In 15 children and 5 adults the original chest films were definite enough to justify a diagnosis of splenic calcifications. There were 33 more suspicious cases. Among the 19 of these 20 patients given the skin tests 9 (47.4 per cent) reacted to tuberculin, while 16 (84.2 per cent) reacted to histoplasmin. Therefore apparently tuberculosis is not the only or even the most frequent cause of calcifications of the spleen in Kansas City, Mo. It is probable that many more cases of splenic calcification would have been found if routine examination of the splenic area with the Potter-Bucky diaphragm had been made.

The percentage of histoplasmin reactors among those with splenic calcifications is almost twice as high as among the general population and about the same as the percentage of histoplasmin reactors among those with lung calcification. This suggests that the agent that causes pulmonary calcifications also causes splenic calcifications, also that the causative agent is blood borne. Three cases were seen in which there were also liver calcifications and these also were probably blood borne.—*Audrey G. Morgan.*

Van Ordstrand, H. S., Hughes, Robert, De Nardi, J. M., and Carmody, Morris G. Beryllium poisoning. *J.A.M.A.*, Dec. 15, 1945, *129*, 1084–1090.

The authors present an analysis of 170 cases of poisoning attributed to the industrial exposure of workers to beryllium compounds, stressing the increasing importance of this substance in industry. During a four year period 170 cases of poisoning were seen by them in three industrial plants using beryllium, its compounds and alloys.

Manifestations of poisoning included contact dermatitis, chronic skin ulcer and inflammatory changes in the respiratory tract. The specific etiology is not known, manifestations apparently being caused by several beryllium compounds,—in this study the sulfating and oxyfluoride processing showing the highest incidence. Clinical manifestations occurred only after exposure and cleared completely when proper precautions were observed or when work was terminated.

Severe manifestations in furnace tenders were those of nasopharyngitis and tracheobronchitis. Tracheobronchitis was characterized by cough, rales in both lungs and normal serial roentgenograms. There was an occasional low-grade fever but the temperature was never elevated over one degree.

Clinical pneumonitis developed in 38 workers and was the severest manifestation of the disease and progressed either to complete recovery or to death. The 5 deaths reported in this series were all attributed to pneumonitis. Clinically the pulmonary changes were characterized by: (1) cough, with occasional blood-streaked sputum; (2) substernal burning pain; (3) shortness of breath; (4) cyanosis in most cases; (5) an abnormal taste; (6) anorexia with weight loss; (7) fatigue.

Physical findings in cases of pneumonitis were: (1) rapid pulse; (2) rales over both lungs; (3) reduced vital capacity. Signs of infection were conpsicuously absent. Roentgenologic changes in the lungs did not usually appear for two to three weeks after the onset of symptoms and physical signs. These changes were bilateral and diffuse in all cases. In order of appearance the changes were: (1) diffuse haziness of both lungs; (2) soft irregular areas of infiltration with prominence of peribronchial markings; (3) absorption of soft infiltration and appearance of discrete large or small conglomerate

nodules scattered throughout both lung fields; (4) clearing of the lungs after one to four months.

Pathologically, affected areas of lung tissue showed large numbers of plasma cells, diffuse edema, hemorrhagic extravasation and relative absence of polymorphonuclear infiltration.—*Charles B. Cobern.*

SPAIN, DAVID M., and HANDIER, BERNARD J. Chronic cor pulmonale. *Arch. Int. Med.*, Jan., 1946, *77* 37–65.

A necropsy study of 60 consecutive cases of cor pulmonale unassociated with other forms of heart disease is the basis for this paper.

The underlying pulmonary conditions in these cases were as follows: emphysema 40; bronchiectasis 6; bronchial asthma 6; silicotuberculosis 3; pulmonary tuberculosis 2; kyphoscoliosis 1; pulmonary arteriosclerosis 1; organized pulmonary thrombi 1. Thus diffuse obstructive emphysema, either primary or secondary to such diseases as pulmonary tuberculosis or silicosis, was considered to be the significant underlying pulmonary factor in the vast majority of the cases.

Diffuse obstructive emphysema was thought to produce a changed pressure relation within the alveoli and in this manner result in an increased resistance to the flow of blood in the lungs. This change was considered to be a primary mechanism in the development of cor pulmonale while such associated factors as anatomic obliteration of the pulmonary vascular bed, fibrosis of the lung, compensatory polycythemia and overfilling of the heart were considered to be aggravating factors of varying significance.

Roentgenographic studies of the chest revealed the changes described above in the pulmonary parenchyma. Great variations were seen in the size of the heart In a relatively small number the cardiac shadow showed definite evidence of enlargement and alterations in the cardiac borders consistent with an enlarged right ventricle. In these cases the left cardiac border showed either straightening or prominent convexity in the area of the pulmonary artery in the posteroanterior view and fluoroscopic examinations revealed the associated displacement of the point of opposite impulse in an apical direction. These classic roentgenographic findings in cor pulmonale were seen in those cases in which the underlying pulmonary change was at a minimum as compared with the interference with the pulmonary circulation, that is, in the case of primary pulmonary arteriosclerosis and in the cases of pulmonary fibrosis with relatively little pulmonary emphysema.

However, in the great majority of cases in this series, the classic roentgenographic picture of cor pulmonale was masked or hidden by the alterations in the chest created by extensive emphysema, fibrosis, pleural obliteration or kyphoscoliosis. In the cases of emphysema the depression of the diaphragm resulted in an elongation of the mediastinum, so that the heart appeared smaller than normal. The increase in lateral diameter of the chest resulting from the elevation of the thoracic cage associated with emphysema made the determination of the cardiothoracic ratio spurious. In a large number of cases of this kind, even minor changes in the cardiac silhouette seen on fluoroscopic examination were of significance. Prominence of the area of the pulmonary artery or of the outflow portion of the right ventricle in the right and oblique position or displacement toward the apex of the point of opposite pulsation were the only changes indicative of enlargement of the right ventricle.—*James J. McCort.*

HARVEY, ELINOR B., and HOGG, PAUL. Thrombosis of the pulmonary artery in children. *Am. J. Dis. Child.*, Jan., 1946, *71*, 67–76.

The authors report a case of thrombosis of the pulmonary artery in a boy, seven years old. Fourteen previously reported cases were found in the literature. The patient's symptoms were of seven months' duration, following an automobile accident causing a contusion of the right side of the chest. The presenting signs and symptoms were cyanosis, dyspnea, fever, cough, hemoptysis and abdominal pain. The roentgen examination of the chest showed an extensive amount of infiltration, spotty in type, extending from the level of the first rib to the diaphragm in the inner zone of the right lung. In the left lung there was a mild amount of infiltration spreading from the left hilum. The picture simulated a pneumonic process of the right lung with failure of the right side of the heart, Severe secondary anemia persisted in spite of therapy. Tuberculosis was ruled out. The condition showed no improvement at any time. Death occurred after two convulsions, probably of anoxemic origin.

On post-mortem examination, an opening was found in the interventricular wall. The pulmonary artery was filled with a laminated thrombus which filled the spaces back of the pulmonic valve flaps and extended slightly into the right ventricle. The thrombus involved the right branch, so that it extended into the pulmonary tissue, practically occluding the vessels which enter the lower lobe, with extension into one branch in the lower portion of the upper lobe. There was massive pulmonary infarction, abscesses of the lower lobe of the right lung, extreme edema of the lungs and acute fibrinous pleurisy.

The origin of thrombosis of the pulmonary artery may be: (1) primary in the vessels or, more commonly, (2) secondary to a disease process outside the pulmonary vessels. The case reported falls into the second category.—*R. S. Bromer.*

Gregg, Grace S., and Gregg, Frank J. Severe rheumatic heart disease in children. *Pennsylvania M. J.*, Dec., 1945, *44*, 247–249.

A study of 101 cases of acute rheumatic heart disease in children is presented. The average age was 8.5 years. The cases were observed in an eighteen month period. Of these, 60 patients were seen iin the first attack while the remaining 41 included many followed during previous admissions or treated elsewhere. Death occurred in 20 cases, 11 during the first attack, 4 during the second and 5 in the fourth attack.

Certain signs were present with much greater frequency in the fatal cases than in those who recovered. Congestive heart failure was noted from the onset in all of the fatal cases reported. These signs were present for varying periods in 15 patients who ultimately recovered. Congestive heart failure is regarded as an ominous sign when it is a part of the clinical picture of rheumatic activity.

A sustained gallop rhythm with the third sound occurring early in diastole was the most unfavorable auscultatory sign in the cases studied. In the fatal cases it was heard in 18 instances. It was also present in 14 patients who recovered. Gallop rhythm is an ominous sign and is regarded as an evidence of rheumatic activity even at times in the presence of a normal sedimentation rate.

Pericardial friction rub was heard in 14 of the 20 fatal cases. In 2 instances there was electrocardiographic evidence of pericarditis without an audible rub. On the other hand, this sign was demonstrated in 9 patients who ultimately recovered. In summary, congestive heart failure, gallop rhythm, and pericardial friction rub, especially when noted together constitute an important triad.

A roentgenogram of the chest was made for heart size and shape when the condition of the patient permitted. Cardiac enlargement of a rather marked degree was seen in all of the fatal cases in which this procedure was carried out. It is well to note the extreme difficulty, if not the impossibility, of differentiating acute cardiac dilatation from acute pericarditis with effusion by roentgenography. The cardiac pulsations ordinarily seen by fluoroscopy or kymography are decreased and may be absent in either of these conditions. This point is regarded as of extreme practical importance in the treatment of these cases. At times the paracentesis of even small amounts of pericardial fluid will result in striking clinical improvement. It is contended that a very careful exploration of the pericardium with procaine anesthesia is a safe and justifiable procedure.

The electrocardiogram proved of little value in detecting significant myocardial changes. The erythrocyte sedimentation test was found to be a reliable procedure to detect the presence of rheumatic activity, although of little quantitative value. The white blood count, pulse and temperature were not reliable indices of the severity of the illness.—*Charles B. Cobern.*

Garland, Leo H. Myocardial infarction—roentgen diagnosis. *U. S. Naval Med. Bull.*, 1944, *45*, 89–96.

Roentgen kymography is a method of recording the movements of an organ on a roentgen film. In multiple slit kymography, which is the form generally used, only the movements parallel to the slits are recorded but by turning the slits at various angles the motions of different parts of the organ may be recorded. This method is particularly valuable in cases of myocardial infarction in which the clinical and electrocardiographic findings are negative or indefinite. This occurs in about 15 per cent of the cases, particularly in the early stages. A negative kymographic finding does not necessarily prove there is no infarction but negative findings with infarction occur in less than 30 per cent of cases. The intensity of the positive

findings increases with increase in the extent and severity of the infarction. The positive kymographic findings are localized decrease or absence of pulsation, systolic expansion or paradoxical pulsation and partial systolic expansion or marked diastolic irregularities.

A case is described in a naval officer forty-eight years of age who was admitted with a diagnosis of angina pectoris. The clinical findings were slight and the electrocardiogram within normal limits. The roentgen kymogram showed waves of poor amplitude over part of the left ventricular margin near the apex with paradoxical motion in frames 3 to 5 above the left diaphragm. A diagnosis of infarction was made. After ten days' rest in bed the patient was discharged. That might he had an attack of severe chest pain, went into shock and died. Autopsy confirmed the diagnosis showing an extensive fresh infarction of the lower part of the interventricular septum and a portion of the anterior wall of the left ventricle; also patchy coronary sclerosis and generalized arteriosclerosis.

Two roentgen kymograms of the case are given.—*Audrey G. Morgan.*

ROBLEE, MELVIN A., and MOORE, SHERWOOD. "Lipiodol" pulmonary emboli following hysterosalpingography. *South. M. J.*, Feb., 1945, *38*, 89–94.

The patient reported had been previously operated upon when sterilization was accomplished by partial tubal resection following a classical cesarean section. Because of the death of her only child, the patient desired operative correction of her sterility. In the course of her study, a hysterosalpingography was performed approximately ten days after her last menstrual period.

Approximately 9 cc. of lipiodol was injected into the uterus at which time the patient began to complain of pain. The intra-uterine pressure was maintained at approximately 140 to 150 mm. of mercury. At the time of the exposure, the patient began to breathe rapidly and an increase in the pulse rate was noted but there was no swelling or other signs of shock. It was not until the roentgenogram was examined that diffusion of the lipiodol into the vascular system was suspected. It was estimated that approximately 5 cc. of iodized oil entered a uterine or tubal vein, probably through the operative defect of the uterus.

The first film of the pelvis revealed lipiodol in all the uterine veins. Approximately fifteen minutes later, a second roentgenogram of the pelvic region revealed only a slight amount of lipiodol either in the large internal iliac veins or lymphatics.

A film of the chest made approximately fifteen minutes after the injection of the uterus revealed a brilliant pattern of the entire bronchovascular tree out to and including the alveoli. Some of the contrast oil was observed in the connective tissues of the arms and chest wall as well.

The patient was hospitalized but except for the presence of some rales in both lower lobes, no abnormalities were noted in the chest. Whereas the patient's urine before injection was essentially negative, the urine after the lipiodol injection revealed a 4 plus albumin. The urine looked red but no red blood cells were noted within it.

A survey abdominal film made twenty-four hours after the accident revealed no lipiodol in the region of the uterus or upper abdomen. Iodized oil was still evident in the chest, however, although it had decreased considerably in quantity. Films of the skull and careful studies of the patient's eye grounds revealed no lipiodol emboli.

A film of the chest obtained twelve days after the accident revealed no residual abnormalities in the lungs.

In reviewing the literature, the author called attention to the fact that many similar cases were reported without untoward results. He called attention to the fact that lipiodol had been injected into humans deliberately without striking sequelae.

In contrast to the normal benign course of lipiodol embolism, the author calls attention to the fatalities that have occurred in many patients following air embolism. He concludes that lipiodol is a much safer medium for hysterosalpingography than air.

The article is excellently illustrated.—*Philip J. Hodes.*

MAHON, GEORGE S. Reaction following bronchography with iodized oil. *J.A.M.A.*, Jan. 26, 1946, *130*, 194–197.

The author presents a case of fatal reaction following bronchography with iodized oil and describes the clinical and pathological changes observed.

Severe or fatal reactions are relatively rare following instillation of iodized oil into the

tracheobronchial tree. White and Bayliss in 1943 could find in the literature to that date only 8 cases of severe reaction, 3 of them fatal. Criep and Hampsey learned of no deaths as a result of questionnaires circulated to 64 physicians doing bronchographic studies on 1,205 asthmatic patients. Although about 300 bronchograms are performed yearly at Mayo Clinic, according to Good "there has never been a fatal accident following bronchography in the memory of any one, including myself, who has worked in this field at this clinic."

The case reported was that of a white man, aged forty-one, admitted to the hospital because of gastroenteritis. The signs and symptoms cleared in twenty-four hours, but a chest roentgenogram showed findings suggestive of bronchiectasis, and bronchographic studies were undertaken. Before bronchography the patient was given 1½ grains of seconal and the larynx was anesthetized with 3.5 to 4 cc. of cocaine. A rubber tube was inserted and 10 cc. of lipiodol was injected into the base of each lung. The roentgen examination was completed and the patient stated he felt well. Shortly afterwards he complained of vague difficulty in breathing. Twenty minutes later he had a severe generalized convulsion, became cyanotic and stopped breathing.

Autopsy showed collapse of both lungs, the cut surfaces of which had the appearance of atelectasis. The tracheobronchial tree was completely filled with thick tenacious mucus which plugged even the smallest bronchioles. Microscopically the bronchi and largest bronchioles had thickened infolded mucosa and the lumens were stenosed and filled with mucus. The basement membrane was thickened and hyalinized. The smaller and terminal bronchioles were dilated and their walls and the peribronchiolar tissues were heavily infiltrated by eosinophils, neutrophils and lymphocytes. The tissue eosinophilia in these areas was striking and seemed to be directly proportional to the severity of the dilatation of the lumens.

The possibility of cocaine poisoning was ruled out by the time interval and the pathologic changes. It was held obvious that the immediate cause of death was asphyxia due to the plugging of the bronchial tree by thick, viscid mucus. The asphyxial nature of death was con firmed by the terminal hyperglycemia of the arterial circulation, a finding noted as a characteristic postmortem finding in deaths due to asphyxia.—*Samuel G. Henderson.*

Finland, Maxwell, Davidson, Charles S., and Levenson, Stanley M. Effects of plasma and fluid on pulmonary complications in burned patients; study of effects in victims of Cocoanut Grove fire. *Arch. Int. Med.*, May, 1946, *77*, 477–490.

The exact cause of the pulmonary lesions in the victims of the Cocoanut Grove fire was not determined. It seemed reasonable to assume that the injuries were the result of prolonged exposure to the ordinary gases and fumes which result from the incomplete combustion of the type of furnishings which were to be found in the Cocoanut Grove building. The severity of the injuries seemed to be related to the amount of actual exposure to these fumes and to the flames before the victims got out into the open air. The symptoms and roentgenologic and pathologic findings were consistent with a severe laryngotracheobronchitis which, because of the edematous and membranous character of the inflammatory reaction in the tracheobronchial tree, gave rise to obstruction of the air passages, which in turn resulted in scattered areas of atelectasis and emphysema.

It is possible, therefore, that the nature of the lesions in these cases could account for the failure of the large amounts of plasma and other fluid to aggravate the pulmonary symptoms. Indeed this form of therapy may have had a salutary affect on the pulmonary lesion similar to that which it may have on surface burns. Pulmonary edema did not occur and respiratory complications, in general, were not aggravated as a result of this therapy.—*James J. McCort.*

Olenik, Jacob L., and Tandatnick, Joseph W. Congenital mediastinal cysts of foregut origin. *Am. J. Dis. Child.*, May, 1946, *71*, 466-476.

A case is reported in this paper of gastroenteric cyst of the mediastinum in a newborn infant. The patient was a nine day old white male infant admitted to the pediatric service because of several attacks of dyspnea, rapid breathing and cyanosis occurring sporadically during the previous two days. The roentgenogram of the chest showed pronounced atelectasis of the lungs with obstructive emphysema at the bases. The cyst, found later at autopsy, was not visualized. Several hemivertebrae were noted in the mid-dorsal area.

The literature was reviewed and 74 cases, including the 1 reported in this paper, were

found. In 35 the cysts were lined with respiratory epithelium; in 12 with primitive esophageal epithelium; in 15 with gastric mucosa; in 4 with intestinal mucosa and in 8 with mixed types of esophageal, gastric, enteric, and respiratory epithelium. In the case reported, the cyst wall in one section resembled the intestinal wall and in another, stomach wall. The authors believe all these cysts have a common origin in the primitive foregut. The classification of the cysts depends on the histologic structure of their mucosal lining and wall.

The symptoms produced by the cysts are due to pressure on the adjoining thoracic structures. The commonest are dyspnea, cyanosis and cough. They usually appear soon after birth. In the authors' case as well as in 6 others reported in the literature, symptoms alternated with periods of comparative comfort. When thoracic cysts are suspected, careful roentgenologic examinations may be helpful. If the cyst is not demonstrated, the authors suggest aspiration of the cyst with introduction of a radiopaque substance.—*R. S. Bromer.*

ABDOMEN

BAUMANN-SCHENKER. Über Paramyloidosis. (Paramyloidosis.) *Radiol. clin.*, Jan., 1946, *15*, 68.

Paramyloidosis is a disease the cause of which is unknown. It is probably due to a disturbance of protein metabolism. In contrast with ordinary amyloidosis none of the known causes of amyloid can be found, such as chronic suppuration due to tuberculosis, syphilis, etc. The usual places of deposit, such as the spleen, liver and kidneys, are free of it, and it is generally the heart muscle, the intestine, the subcutis, the parotid, the thyroid and the gastrointestinal canal that are affected. Histologically paramyloid differs from ordinary amyloid in that the staining reactions are different and there is no metachromasia.

Roentgenologically the changes in the gastrointestinal canal are of the greatest interest, as the deposits in other places can as a rule not be demonstrated by roentgen examination.

A case is discussed in a patient who died at the age of forty-one. There was a very extensive and diffuse amyloid infiltration of the stomach, esophagus, and small intestine. The mucous membrane folds were greatly swollen; in the small intestine they were as large as stomach folds, the intestine was rigid and peristalsis affected. In extreme cases no peristaltic activity can be seen on the roentgen screen. There were no roentgenologically demonstrable deposits in the colon and pathological examination did not show any amyloid deposits there.

Differential diagnosis is discussed. The case was confirmed on autopsy. (Author's abstract.) Translated by *Audrey G. Morgan.*

ETTER, H. Über die Röntgendiagnostik des terminalen Ileum. (Roentgen diagnosis of the terminal ileum.) *Radiol. clin.*, Jan., 1946, *15*, 62–67.

The position and course of the terminal ileum shows three types: it often rises from the pelvis parallel to the cecum and empties into the median wall of the cecum at an angle acute downward. Almost as frequently it runs from medially and below to laterally and upward and empties into the cecum straight or slightly twisted. Somewhat less frequently it forms a large ascending arch which empties into the cecum at an acute angle. The large arch may change its position and stretch as a result of peristalsis alone, but otherwise the types remain constant. The terminal ileum shows very marked peristalsis which pushes the contents through Bauhin's valve into the cecum. When the mucous membrane folds run parallel with the course of the intestine, transportation is furthered and when they run transversely it is retained and mixed. Peristalsis is a function of the muscularis mucosae and the transportation or retention relief is brought about by the autoplastic function of the muscularis mucosae.

There is greater variation of tonus in the terminal ileum than in other parts of the intestine and therefore caution is necessary in diagnosing terminal ileitis. Illustrative roentgenograms are given.

In the discussion Mathez said that he disagreed with the author in regard to the three constant types of form of the terminal ileum. He has seen two or all three of these forms succeed each other in the course of a single examination.—*Audrey G. Morgan.*

PLENGE, H. E., and ROSS, J. N. Roentgenologic examination of the stomach with patient under sodium pentothal anesthesia. *South. M. J.*, March, 1945, *38*, 183–185.

The importance of differentiating between spasm and organic infiltration of the prepyloric

portion of the stomach is recognized by all roentgenologists. The fact that pilocarpine, atropine, belladonna, and other antispasmodics do not relax spasm in this portion of the stomach has been repeatedly demonstrated. The author believes a general anesthetic may help differentiate spasm from organic infiltration. He used sodium pentothal intravenously in 3 patients in whom prepyloric antral spasm had been repeatedly demonstrated and found that the spasm relaxed when the anesthetic took effect. The author believes general anesthetics should be used much more frequently in patients suspected of having antral spasm rather than organic infiltration.—*Philip J. Hodes.*

Hudson, Paul L. Echinococcus disease; report of three cases of calcified cysts of the liver. *South. M. J.*, Sept., 1945, *38*, 584–589.

The author reports 3 cases of calcified echinococcus cysts of the liver encountered in patients who were natives of the state of Georgia. All revealed well defined calcified masses in the region of the liver by roentgen examination.

Whereas the disease has usually been associated with sheep, there is good evidence now that hogs and cattle are important intermediate hosts for the parasites.

In discussing diagnostic criteria, the dangers of diagnostic puncture of the cyst are considered. Not only can this puncture spread the infection but it may be misleading as clear fluid may be obtained from the cyst which will contain no characteristic hooklets or scolices.

Significant eosinophilia is reported in only about 25 per cent of the patients with echinococcus disease.

Immunological responses developed by the hosts have been utilized as diagnostic aids. Considerable work has been described concerning serum precipitin and complement fixation reactions. Skin tests for echinococcus disease have been reported positive in 90 per cent of proved cases, although false positive reactions are not rare. Old cysts often fail to react in positive manner to skin tests because the immune response of the body is often lost after the cyst degenerates. The importance of using fresh cyst fluid for these tests is re-emphasized.

The article contains excellent roentgenograms revealing the various types of calcified cysts found in and around the liver.—*Philip J. Hodes.*

Morrison, M. C. Radiological findings in lesser sac effusion. *Canad. M. Ass. J.*, May, 1945, *52*, 474–477.

Of the two cases presented, in one the lesser peritoneal cavity contained considerable air as well as fluid; in the second, the space was occupied by bile following cholecystectomy.

At postmortem examination, the first patient proved to have a congenital diverticulum of the left half of the diaphragm which contained the fundus of the stomach as well as spleen. Apparently, strangulation and perforation of the stomach with extravasation of gastric contents into the lesser peritoneal cavity had taken place. The roentgenogram made in the anteroposterior projection revealed a large collection of air in the gastric region which had the appearance of a markedly distended stomach. The splenic flexure of the colon was displaced downward to the iliac crest.

The second patient had had a cholecystectomy for an acute cholecystitis. Approximately three months after the original operation, the patient returned to the hospital complaining of pain in the left shoulder and epigastric distress. At operation, approximately 1,000 cc. of brownish-yellow fluid was drained from the lesser peritoneal sac.

The roentgenograms of the chest made prior to operation revealed a pleural effusion in the left chest, secondary to the subphrenic infection. The films of the abdomen revealed a barium-filled stomach displaced posteriorly as well as somewhat inferiorly and toward the midline. Definite evidence of extrinsic pressure upon the stomach was clearly defined.—*Philip J. Hodes.*

SKELETAL SYSTEM

Pridie, Kenneth H. A new method of treatment for severe fractures of the os calcis; preliminary report. *Surg., Gynec. & Obst.*, June, 1946, *82*, 671–675.

In the past a fracture of the os calcis was a relatively rare injury, confined very largely to window cleaners. Modern warfare, however, with the introduction of the torpedo, land mine, paratroop landings, and other features of warfare, has increased not only its absolute incidence, but also the relative frequency of the severe, highly comminuted type. Despite the most energetic treatment, the resultant disability remains a serious one. Patients are left with persistent pain, stiffness, inability to walk

over rough ground or do ladder work, or indeed any form of hard manual labor.

In those cases in which the subastragaloid joint has not been affected, early movements and freedom from weightbearing for six weeks produce good results, and the patients are able to return to their preaccident occupations. But in others, even when the fracture does not appear to be a serious one, subastragaloid arthritis develops out of all proportion to the roentgen findings so that the end-result is much worse than would be expected, the disability consisting, as before, of pain and stiffness. Despite individual variations in tolerance to pain, the findings in a large number of patients are remarkably consistent.

Forms of Treatment.

1. Boehler's method of applying skeletal traction to the back of the os calcis and at the same time compressing the bone from side to side by means of a redresseur has not produced any better end-results nor has it prevented stiffness or subastragaloid arthritis.

2. Late arthrodesis of the subastragaloid joint proved so disappointing in the author's hands that it was abandoned and early arthrodesis was tried.

3. However, early arthrodesis is difficult for the soft tissues are badly bruised and infiltrated with blood, while the os calcis is not so much a bone in fragments as a bag of bones. The satisfactory removal of the articular cartilage from the subastragaloid joint surfaces is a procedure of great difficulty.

4. In the normal leg and foot three joints provide the necessary movements which allow the foot to adapt itself to the ground and permit easy walking. They are the ankle, the subastragaloid and the midtarsal joints. When the latter two become stiff it is impossible for the individual to use his foot in the normal way because only simple dorsiflexion and plantar flexion are left to him. As a result of this experience it was decided to perform *total removal of the os calcis for the seriously comminuted type.*

After Treatment. The foot is immobilized in the original plaster for one month. The position of plantar flexion is maintained to ensure relaxation of the Achilles tendon so that its new attachment to the plantar fascia is not strained. At the end of four weeks the sutures are removed and active nonweight-bearing exercises are commenced. The important exercises are inversion, eversion, and circumduction. Post-traumatic edema is prevented by insisting that the leg be not allowed to hang down during the weeks immediately following removal of the cast except during periods of exercise. When the patient feels able to walk he is encouraged to do so. The average period is about six weeks. It is important to see that he is taught to walk correctly and without a limp.

Results. This new method of treatment of fractures of the os calcis has been performed 15 times to date and the 2 cases reported in this article were the first and therefore have been observed over a considerable time (3 years and 2 years respectively).

Conclusions. The results of this operation have been gratifying. It probably should be reserved for the severely comminuted fractures and, like other excisions of bones in the foot, it is a somewhat difficult operation because of the strong ligaments attached to the bone. Unless one is careful to avoid a postoperative hematoma there is risk of sepsis. The operation should be performed as soon as possible after the injury in order to prevent intrafascial tension from bleeding and edema which causes ischemia and subsequent congealing of the intrinsic muscles and leads to stiff midtarsal joints and stiff toes.

The chief advantages of this method are:

1. Freedom from pain.
2. Good range of inversion and eversion.
3. Mobility of the whole foot.
4. Good toe action.
5. This operation will undoubtedly save many an injured foot from amputation.—*Mary Frances Vastine.*

BRAY, ERNEST A., and FITTS, WILLIAM T. Gunshot fractures of the femoral shaft. *Surg., Gynec. & Obst.*, Jan., 1946, *82*, 91–100.

This study is based upon a series of 82 cases received at a General Hospital during the campaign in North Burma from October, 1943, to August, 1944. It includes all complete compound fractures of the femoral shaft, some of which were comminuted into the knee joint.

Summary of Important Points. The function of the forward surgical groups is the treatment of shock and hemorrhage, adequate debridement of wounds, institution of prophylactic chemotherapy, immobilization of fractures, and early evacuation. Definitive treatment of fractures should be reserved for the fixed installations.

In the prevention of infection, the most important single factor in the early treatment of wounds is the adequacy of the debridement.

A spica plaster is a satisfactory method of temporary immobilization. Nonpadded plasters should not be used, but if used by necessity, they should be split through their entire length before transportation.

No ankle or instep hitches should be used in connection with Army leg splints.

Early inspection of the wound at the fixed medical installation is advisable to rule out infection, especially by gas-forming organisms. Afterward, dressings should be reduced to a minimum.

Incision and drainage should be instituted early when there are knee joint infections or deep subfascial abscesses. Dependent counter incisions are necessary.

Circulatory impairment is serious and not uncommon. It must be recognized early and the cause eliminated.

Anemia, malnutrition, and the effects of exposure must be combatted. Early replacement of blood loss by whole blood transfusion improves the general condition of the patient and helps to prevent infection.

Balanced skeletal traction suspension is a very satisfactory method of treating these patients in a fixed installation.

When traction suspension is used, the possibility of gravitational abscesses should be watched for and early drainage should be accomplished.

Kirschner wires through the lower femur and upper tibia proved very satisfactory, and there were no untoward effects. Each location has its advantages for certain types of fracture. The wires should be changed from one location to another when indicated.

Posterior angulation of lower femoral fractures can be corrected by placing the wire through the tibial tubercle and making the traction in the line of the tibia instead of the femur.

Repeated roentgenologic examination is essential in treating these cases by traction suspension. Overpull must be avoided.

When there is associated knee joint infection, flexion of the patient's knee in the traction suspension apparatus should be limited to 5 degrees.

Traction should be continued until there is roentgenologic evidence of bone union. The average time for bone union was twelve weeks. Knee joint motion should be encouraged after eight weeks.

Forceful manipulation of the knee is of no value and may do harm. Wedge plasters, however, are of considerable assistance in the relief of persistent joint stiffness.

Secondary hemorrhage from a wound, however slight, is a positive indication for immediate exploration.

Refractures usually heal, but convalescence is considerably prolonged thereby. Patients with precarious union should be kept in suspension for an added length of time. Afterward, leg braces should be used when they are available.

Bone infection did not predispose to nonunion, nor did it significantly delay the time of bone union as seen on the roentgenograms. However, refracture in these cases must be avoided by a longer period of immobilization than in the clean cases.

The osteomyelitis seen in these cases was localized, minimal, and easily controlled. It is possible that it was limited by the use of sulfonamides.

Retained metallic foreign bodies did not appear to predispose to bone infection.

There was a mortality of 4.9 per cent. Bone infection of some degree was noted in 28 per cent. Bone union occurred in 96 per cent of the survivors. The known functional end-results of 67 followed cases were good in 67 per cent, fair in 24 per cent, and poor in 9 per cent.—*Mary Frances Vastine.*

Macdonald, Ian, and Budd, John W. Osteogenic sarcoma; roentgenographic interpretation of growth patterns in bone sarcoma. *Surg., Gynec. & Obst.*, Jan., 1946, *82*, 81–86.

The appearance of a bone tumor at a given time depends upon the balance between neoplastic activity (osteolysis), and the degree of cortical and medullary reaction (sclerosis), as well as the absence or extent of ossification and calcification. The "sun ray" appearance of many osteosarcomas may be due either to new bone formation or calcification in parallel striae and may be seen in chondrosarcoma and even in neoplastic metastatic lesions of bone. Even Codman's time-honored reactive triangle may be seen in chronic periostitis. In short, "typical" roentgenographic features are a reflection of

growth characteristics rather than an indication of tumor types, a kinetic rather than a static concept.

The observations presented here are part of a study of 118 cured cases of bone sarcoma, and a smaller number of uncured cases, from the Registry of Bone Sarcoma of the American College of Surgeons.

Definition. "Osteogenic sarcoma" applies to those sarcomas arising in the connective tissues of bone, distinguishing this numerically large group from those of less frequent incidence arising in hematopoietic, endothelial, and adipose tissue elements of the medulla.

Proposed Division of the Connective Tissue Sarcomas. (1) Osteosarcomas—bone-producing sarcomas. (2) Chondrosarcoma. (3) Fibrosarcoma.

The roentgenologist may make a diagnosis of osteogenic sarcoma with reasonable expectation of verification if there is evidence of a cortical, malignant tumor. Roentgenographic criteria are highly unreliable in attempting a more accurate differential diagnosis of osteogenic sarcomas.

Osteosarcoma. This is a highly lethal disease. It arises in the metaphysis and may be predominantly sclerosing or osteolytic. The former type is the more common and it may be peripheral or central in origin. The peripheral sclerosing is the classical type in which the tumor early elevates the periosteum, usually with dense radiating striae and Codman's reactive triangle. With continued growth there is progressive sclerosis of the cortex and medulla, and soft tissue extension in advanced cases. The only sign of central sclerosing osteosarcoma may be a dense obliteration of the cortical striae while secondary destruction in the medulla produces a mottled appearance.

The pure osteolytic form of osteosarcoma is the old "telangiectatic bone aneurysm" and represents a rare and extremely anaplastic form. There is irregular, expansile destruction of the cortex, little or no periosteal reaction. There may be early perforation and bulky soft tissue masses, invasions of the epiphysis and adjacent joint.

Chondrosarcoma. Chondrosarcoma is less malignant than osteosarcoma but more so than fibrosarcoma. It arises in the ends of the diaphyses of long bones, in flat bones and vertebrae. There are two well defined forms, peripheral and central. In the former, an irregular, productive periosteal growth is the earliest stage. Calcification is extremely common in chondrosarcoma. It may early perforate the periosteum and produce bulky, lobulated, soft tissue tumors, or blotchy, irregular masses of calcifying neoplasm. Calcification may also occur in linear, striated style, simulating peripheral sclerosing osteosarcoma.

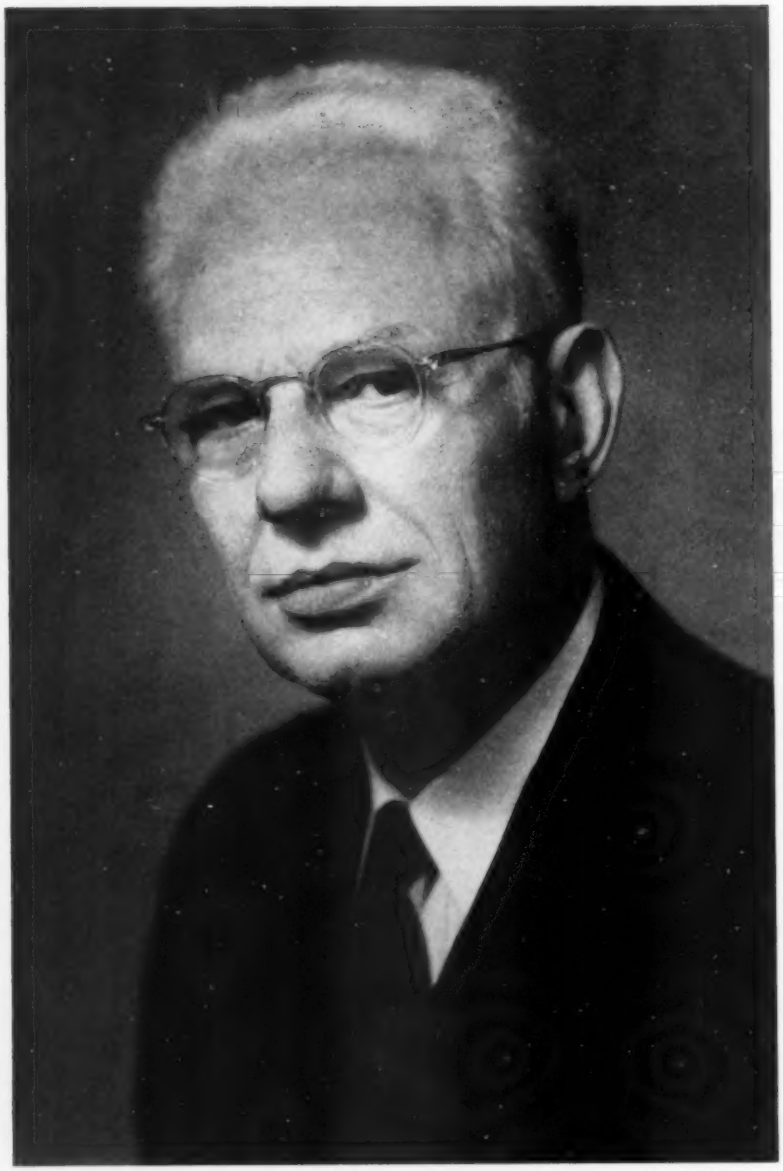
The central type of chondrosarcoma often produces irregular areas of rarefaction, usually with adjacent reactive sclerosis, forming a shell around the tumor. Eroded areas may appear cystic and resemble fibrosarcoma. Sclerosis and calcification may predominate in the central type, with dense ivory-like obscuration of architecture.

Fibrosarcoma. This is the most benign form of the connective tissue sarcomas. It may arise in any part of the long bone including the epiphysis. It is a frequent form of sarcoma of flat bones. The most common form is the osteolytic. In its early stage its origin may be evident as medullary, cortical, or periosteal. It may enlarge to form a single predominantly destructive lesion, with little or no reactive sclerosis or periosteal thickening. These tumors are usually non-expansile. Roentgenographic evidence of extension is frequently that of an irregular spotty osteolytic process with or without sclerosis of adjacent bone. Multiple cyst-like areas are not uncommon and should not be confused with giant cell tumors. These forms are frequently slow in growth and five year cures have been obtained by amputation after repeated local operations.

There is an advanced diffuse osteolytic form of fibrosarcoma, less common, which affects one-third or more of a large bone, in which there are linear and circumscribed areas of rarefaction with intervening strands of sclerosing bone. The result is a ragged, moth-eaten appearance which may simulate Ewing's sarcoma.

In any soft tissue fibrosarcoma, ossification may occur. Most ossifying fibrosarcomas in bone in the past have been diagnosed as osteosarcoma.

Differential Diagnosis. The simulation of primary bone tumors by metastatic lesions has been observed repeatedly.—*Mary Frances Vastine.*



J. BENNETT EDWARDS

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1947-1948